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Power Generation

March, 1948

VOLUME 52—NUMBER 3

Engineers' Preview 7
Helpful Bulletins 37
New Equipment News 44
What Leaders Say 55
Harbor Steam Plant Nears Completion 56
By William C. Rowse and John Paul Stratford
Facts About Steam Turbines for Industrial Plant Owners 63
By Glen D. Farrar
Midget Motor 66
The Voltage Regulator—What to Expect of It 68
By G. A. Hanlon and R. E. Lloyd
The Practical Engineer 71
Post-War Research in Unnatural History 89
Atomics 90
The Significance of the Nuclear Reactor in Atomic Development
By Andrew W. Kramer
A Plea for International Understanding
By Albert Einstein
Where to Put Overfire Jets 95
By William S. Major
What's New in the Electrical Art? 98
What It Cost to Run 10 Diesels for 4 Years 100
Fatigue Cracking of Retaining Ring Causes Turbine Accident 104
Power Turbines for Natural Gas Expansion 110
By Stephen Bencze
The Electrogyro—Something New Under the Sun 114
Heat Recovery Utilizing Flash Steam Regeneration 118
By M. C. McKeown
Coming Events 116
Obituaries 128
News from the Field 136
New Engineering Books 144
Catalog Library 148
Construction News 162

Contents of back issues of Power Plant Engineering and Power Generation will be found in Industrial Arts Index on file in Public Libraries.

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Entered as second class matter February 10, 1948 (original entry May 1, 1908), at the Post Office, Chicago, Illinois, under act of March 3, 1879.

Scores greatest triumph—*in a selected field*—on a hard going, heavy course.

We picked the cream of abrasion resistant alloys—made discs of them—*carefully weighed them*—keyed them on a shaft—*churned them thru a mixture of sharp sand, emery, metal filings and other slurries for hours*—removed them —*carefully weighed them again*—calculated the loss due to abrasive action.

We knew Ashcolite would win, but not by such a wide margin. A large chemical company learned this the hard way; they tried them all. You can benefit the easy way.

When abrasion is the problem—Ashcolite is the metal. We make Ashcolite Pipe, Ashcolite fittings and use Ashcolite in Hydroseal Materials Handling Pumps, etc., etc.
The Allen-Sherman-Hoff Co., 233 S. 15th St., Phila. 2, Pa.

ENGINEERS' PREVIEW

RADIO NOISE generated by the sun is now being studied at the National Bureau of Standards. This is a companion project to cosmic radio noise studies already in progress. The new investigation will seek to determine the range of frequencies broadcast from the sun, received intensities, and correlation of solar noise with other solar, interstellar, and terrestrial phenomena.

With the use of higher and higher frequencies in communication and radar equipment, both solar and cosmic noise have come to be recognized as increasingly important. Recent advances in design for both very-high and ultra-high frequency receivers, which practically eliminate internal set noise, indicate that the limiting factors in the use of the equipment will be those arising from natural phenomena.

★ ★ ★

SHOULD AN ARBITRATOR have a private conversation with one of the parties in a dispute during the arbitration? Is it ethical for an arbitrator owning—say—100 shares in a corporation with 1,000,000 shares to serve in a case where that corporation is involved? Should an arbitrator keep a fee that has been paid him by one party if the other party defaults in the payment of his fee?

These and scores of other questions go to the root of the primary requirement for the integrity of the arbitral process. Every business concern, every labor union, the bench, the bar, government and the general public are all deeply concerned in maintaining and improving the standards of the nation-wide system of private justice which has been created in the United States since 1926 when the American Arbitration Association was established in New York to develop and administer this system.

To safeguard the interests of those who bring to arbitration for settlement these disputes in human relations, the Association promulgated the first Code of Ethics for arbitrators in 1927. Now it announces that it is asking industry, labor, the press, members of the bar and bench, representatives of domestic and international trade and commerce, and the arbitrators themselves to contribute the results of experience and observation to a review of the Code of Ethics which governs its panels.

Copies of the Code are available upon request. The Association's offices are at 9 Rockefeller Plaza, New York 20.

★ ★ ★

TO PROVIDE research training and experience for engineers headed for careers in industry and government, a new program has been announced by Dean Gordon M. Fair of the Harvard Graduate School of Engineering. The new course will require two years of study beyond the bachelor's degree and lead to a Master of Engineering degree. Offered for the first time in the fall of 1948, the new master's degree is designed as a terminal degree for those men who desire research experience, but want to start their engineering careers without going on to the three-year doctoral degree.

"THE ELECTRIC UTILITY industry is intensely interested in the heat pump because it holds promise of permitting the industry to supply domestic heating service in an economical manner. Up until now the electric utility industry has supplied very little of this market and we think that without the heat pump we are not likely ever to supply very much of it." These statements were made by S. W. Andrews, Engineer, American Gas and Electric Service Corp., before the January Mid-Winter Convention of AIEE at Pittsburgh.

Mr. Andrews went on to point out that the market is a big one. It has been estimated that the heat required for domestic house heating, if translated into kilowatt hours of electric energy, would amount to 700,000,000,000 kw hr as compared to with the total sales of electric energy in 1945 to residential customers of 34,000,000,000 kw hr. A market of this size naturally holds out great attractions to the utility industry if it can be developed so that it will be advantageous to the supplying companies, to the manufacturers of equipment, and to the customers themselves.

Mr. Andrews then went on to explain the reasoning behind the foregoing statements and conclusions. At present, although there are a number of heat pump units in operation, both in this country and in parts of Europe, there seems to be some difficulty in actually getting heat pump units manufactured in this country at a low enough cost, yet at the same time capable of meeting the necessary standards of performance and reliability. Another factor that must be investigated further, before the heat pump can go ahead with any rapidity, is the determination of the proper heat source, whether it is the outside air, ground water, or the ground itself. Much work is being done on this phase of the subject and it may not be long before some authoritative data will emerge.

★ ★ ★

SMOKE NEED NOT roll from boiler plants, steamboats, or locomotives. Public demands have forced municipal authorities to institute programs for the elimination of air pollution with resultant rulings that smoke from plants, steamboats, and railroad engines must be reduced as far as is technically possible. . . .

Through study of the various methods of smoke abatement, Bituminous Coal Research, Inc., became convinced that the overfire jet, when properly designed and installed, was the simplest device for smoke elimination.

BCR offers in four publications the story of overfite jets, their design, construction, and application for stationary plants, locomotives, and steamboats.

These publications are: Technical Report VII, Application of Overfire Jets to Prevent Smoke from Stationary Plants; Technical Report VIII, Overfire Jets and Controls for Locomotive Smoke Abatement; Application of Overfire Jets to Steamboats, and Overfire Jets in Action, a booklet which spotlights several typical overfire jet installations and the results achieved. . . . To obtain these four publications write to Technical Information Service, Bituminous Coal Research, Inc., 912 Oliver Bldg., Pittsburgh 22, Pa.

HARD METAL that retains strength and resistance to corrosion at high temperatures, has resistance to oxidation and hot gases, also abrasion resistance and hardness, suggests uses on jet engines, gas and steam turbines rotating parts exposed to elevated temperatures, furnace parts and other high heat structures. Essentially it is titanium carbide with cobalt as a bonding agent; is formed by powder metallurgy into a variety of shapes and sizes with conventional finishes and tolerances. This special composition, formed like other carbides for wear-resistant parts and cutting tools, has unique properties. It withstands temperatures that destroy other carbides and the best cast alloys; resists thermal shock better than ceramics; has a specific gravity 1/3 that of tungsten carbide, 2/3 steel. Grade K-138 has been heated to 2,100 F for 48 hours without loss of strength; no appreciable change was noted when heated to 1,800 deg. and quenched in water, nor after air cooling from the same temperature except slight surface discoloration.

★ ★ ★

AIR WARDEN, an automatic pressure valve for use on compressed air supply lines is used on primary pressures to 150 psi, can be set to maintain secondary pressures from 125 down to 5 psi. It has a free-floating valve stem so it is possible to reduce the delivered pressure under dead-end conditions by turning the adjusting screw, to allow pressure reduction without exhausting the cylinder. Also provides high precision control, protection against pressure build-up, contributes the stabilizing effect so desirable in handling sudden pressure changes. Model RD-1 is for 3/8-in. and RD-2 for 1/2-in. lines.

★ ★ ★

CENTRIFUGAL PUMP with a concentric casing to reduce turbulence is said to eliminate the cavitation of volute-cased pumps. Single-stage suction-type with large non-clogging passage to permit handling liquids with solid content and slurries. Only four removable parts in contact with fluid—casing, impeller, wear plate and shaft, may be had in any workable alloy. Large range of capacities and differing head requirements can be handled through impeller diameter change, or casing and impeller shift. Repairs can be made simply and rapidly.

★ ★ ★

A NEW water pump shaft seal has spring chucks concentrically over the synthetic reel-shaped boot to facilitate handling as a unit. The boot flanges are cemented into the cartridge cup and onto the thrust washer. It is installed by pressing the cartridge to its seat on the flange, in a specified-diameter cavity. A somewhat similar main engine bearing seal is made with hardened steel and fabric parts bonded within a precise circular length of oil-resistant synthetic rubber.

★ ★ ★

EXPANSION JOINTS capable of absorbing movement of high-temperature lines axially, laterally, angularly or any combination of these consist of two corrugated elements linked together by a section of pipe. Expansion elements can be the non-equalizing type for pressure to 30 lb, or self-equalizing for higher pressures. Each joint is designed to fit the requirements of each application; can be supplied for all temperatures and pressures.

CHEMICALS of an oily character that dissolve clearly in water have recently been announced as available in commercial quantities. They are polyoxyethylene oleates and laurates having a molecular weight above 800. They are non-ionic, non-toxic, light in color and fluid or grease-like in consistency. They dissolve clearly in water, alcohol, esters, hydrocarbons and vegetable oils. At 20 C (68 F) they are slightly heavier than water. They all have high boiling points and exhibit surface-active properties. The above properties indicate their use as special detergents in textile and fiber processing; as penetrating lubricants; grinding media for pigments; plasticers for water-dispersed products and water-insoluble resins, elastomers, plastics, coatings, etc.; emulsifying agents for oils and hydrocarbons.

★ ★ ★

JUST WHAT every power engineer in the country has been waiting for—the equipment described in a recent newspaper item reproduced below. Wouldn't it be just ducky for the boiler or turbine room engineer to have, right on the main operating floor in front of the control panels?

"A desk that does almost everything but figure percentages has been created for the busy business man.

"As he pulls up his swivel chair to begin the day's work, an electric eye sets off a transcribing machine that says 'Good Morning!' and brings him up to date on appointments. Other features include an electric razor outlet, cigaret lighter, barometer, a safe for confidential papers and a compact refrigerator to provide snacks for the executive or refreshments for important guests.

"In addition are: time-saving fingertip panels that control air conditioning, room lighting, intercommunication; a recording system; and a dictating machine. The desk is semi-circular with a 12-ft top, designed so the executive can reach any part of it from his chair."

Nothing is said about including an oxometer.

★ ★ ★

TO CREATE bends in pipe portable Roll-A-Bend bench tool has a roller that is easily adjusted to fit the mandrel being used. Any bend to 180 deg can be made in one operation. Mechanically operated by one man but can be converted to power operation. Weight 340 lb with all mandrels. Will bend 1/2, 3/4 or 1 in. pipe through 8, 12, 15, 18 or 24 in. mandrel sizes and 1 1/4 and 1 1/2 to a variety of sizes.

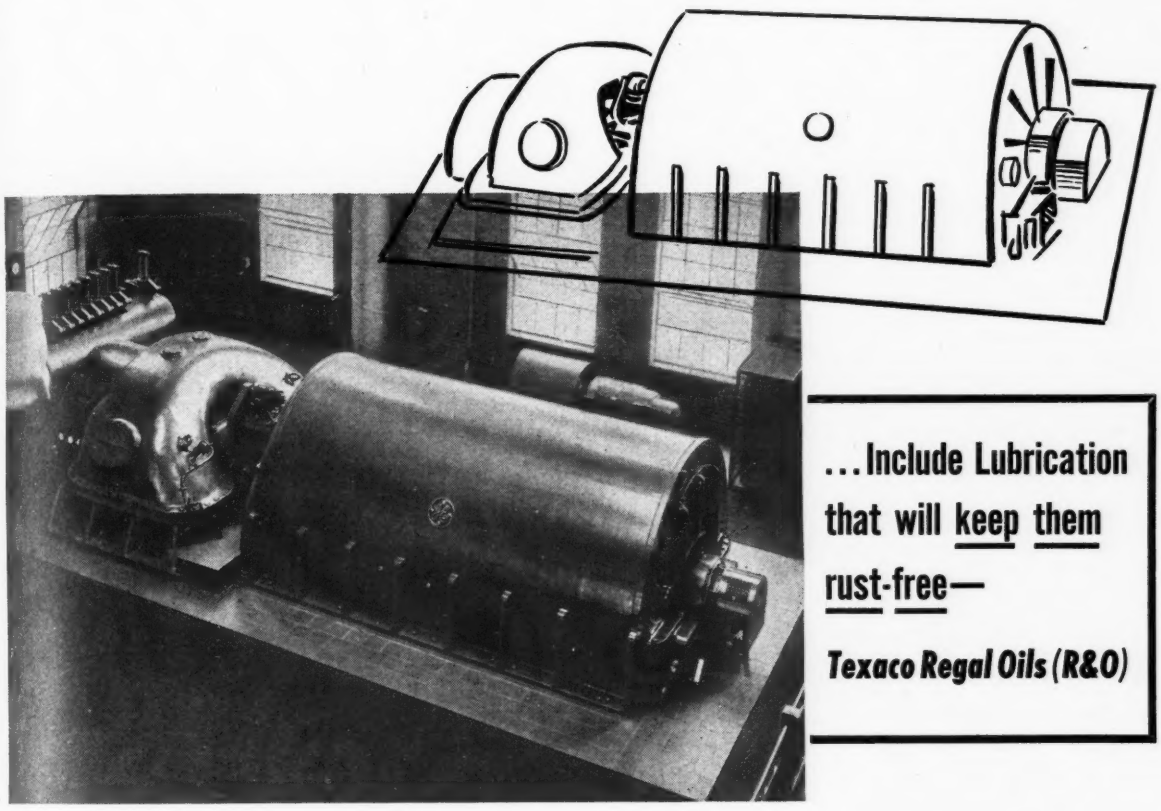
★ ★ ★

FOR USE on mercury units (boilers, heaters, etc.) producing vapors that attack copper and bronze, a vacuum valve has cast medium carbon steel body, high-test iron cover, stainless steel bellows welded to stainless disc holder, valve disc and sealing ring of silicone rubber. Connecting flanges are recessed and fitted with silicone rubber sealing rings.

★ ★ ★

STAINLESS STEEL valve with a rising stem has renewable neoprene, hard rubber or fiber valve seat. Specially-designed swivel allows pressure to be applied in closing without turning the valve on its seat, eliminating usual abrasive action. For use in all industries where stainless steel valves are needed; is of 18-8 Mo type 316, in 1 1/2, 2 and 3 in. sizes.

In Your Plans for New Turbines



...Include Lubrication that will keep them rust-free—

Texaco Regal Oils (R&O)

YOU can't keep moisture out of your turbine lubricating systems, but you *can* prevent it from forming rust. When a new turbine, for example, is charged with *Texaco Regal Oil* (*R & O*), a special rust inhibitor immediately "plates out" on the metal. Thereafter, no moisture can reach the metal. Rust gets no chance to form.

Rust prevention is only one of many benefits you get with *Texaco Regal Oils* (*R & O*)—the world-famous Texaco Regal Oils *improved* with inhibitors against oxidation as well as rust, and specially processed to prevent foaming. *Texaco Regal Oils* (*R & O*) assure clean lubricating systems in both new and old turbines . . . freedom from rust, sludge and foam . . . normal bearing temperatures . . . instant governor response . . . and extra long oil service life.

Texaco Regal Oils (*R & O*) are approved by all leading turbine manufacturers and meet the turbine oil requirements of the United States Navy.

Let a Texaco Lubrication Engineer tell you about the complete line of Texaco Lubricants for every power plant requirement. Just call the nearest of the more than 2500 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO REG. T.M.

TEXACO Regal Oils (R&O)

FOR ALL TURBINES

TUNE IN . . . TEXACO STAR THEATRE presents the TONY MARTIN SHOW every Wednesday night. • METROPOLITAN OPERA broadcasts every Saturday afternoon.

NORTH

WEST EAST

SOUTH

it's YARWAY

From every corner of the country comes the same story—four out of every five high pressure boiler plants are equipped with Yarway Unit Tandem Blow-Off Valves.

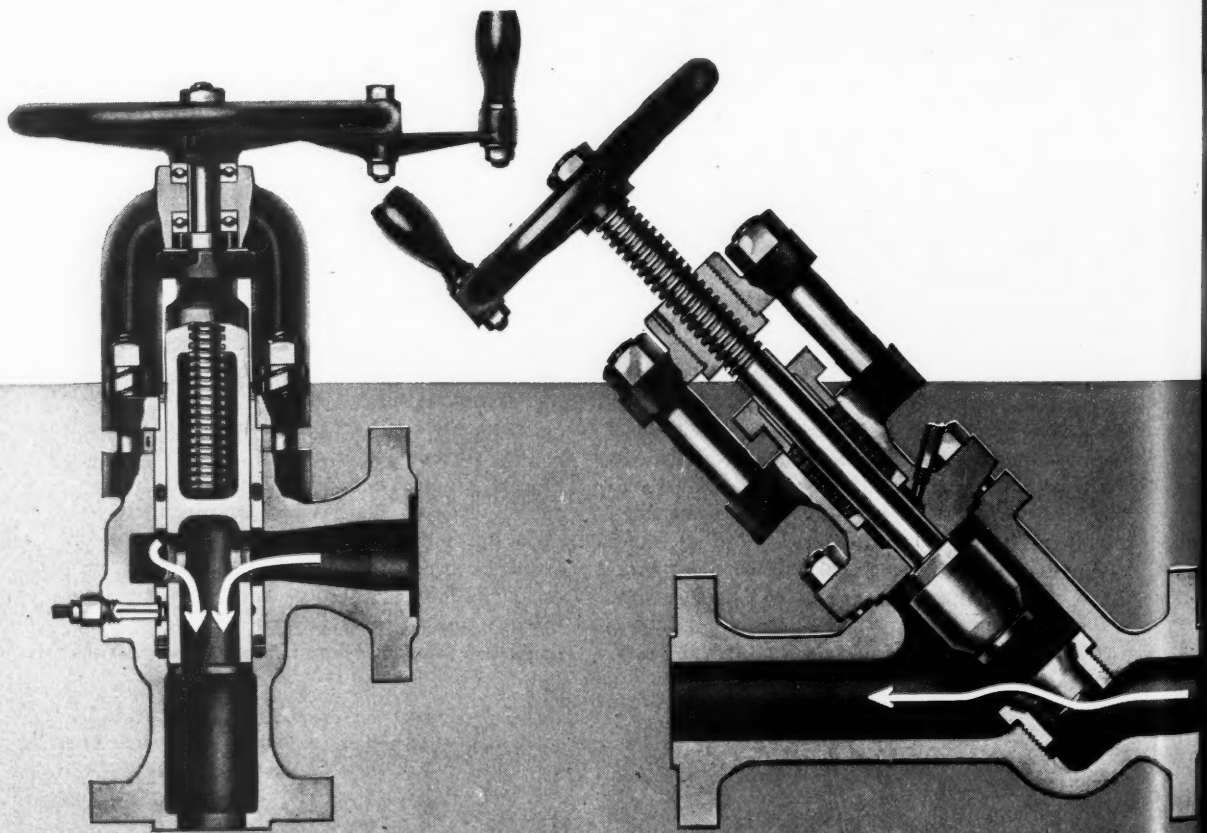
Each day's orders add to the evidence. From Ohio . . . 17 new Yarways, making a total of 746 purchased by this large utility over the last 35 years. From California . . . 10 new Yarway Unit Tandems for one company, 9 for another. Texas sends an order of 5 . . . 3 for one new municipal plant, 2 for another. Northern New York wants 7 for new boilers in a well-known utility. And so it goes.

Why this overwhelming preference?

Proved dependable performance, due to outstanding design, sound engineering and careful manufacture . . . plus constant research, leading to mechanical and metallurgical advancements that keep Yarway Valves ahead of changing service requirements.

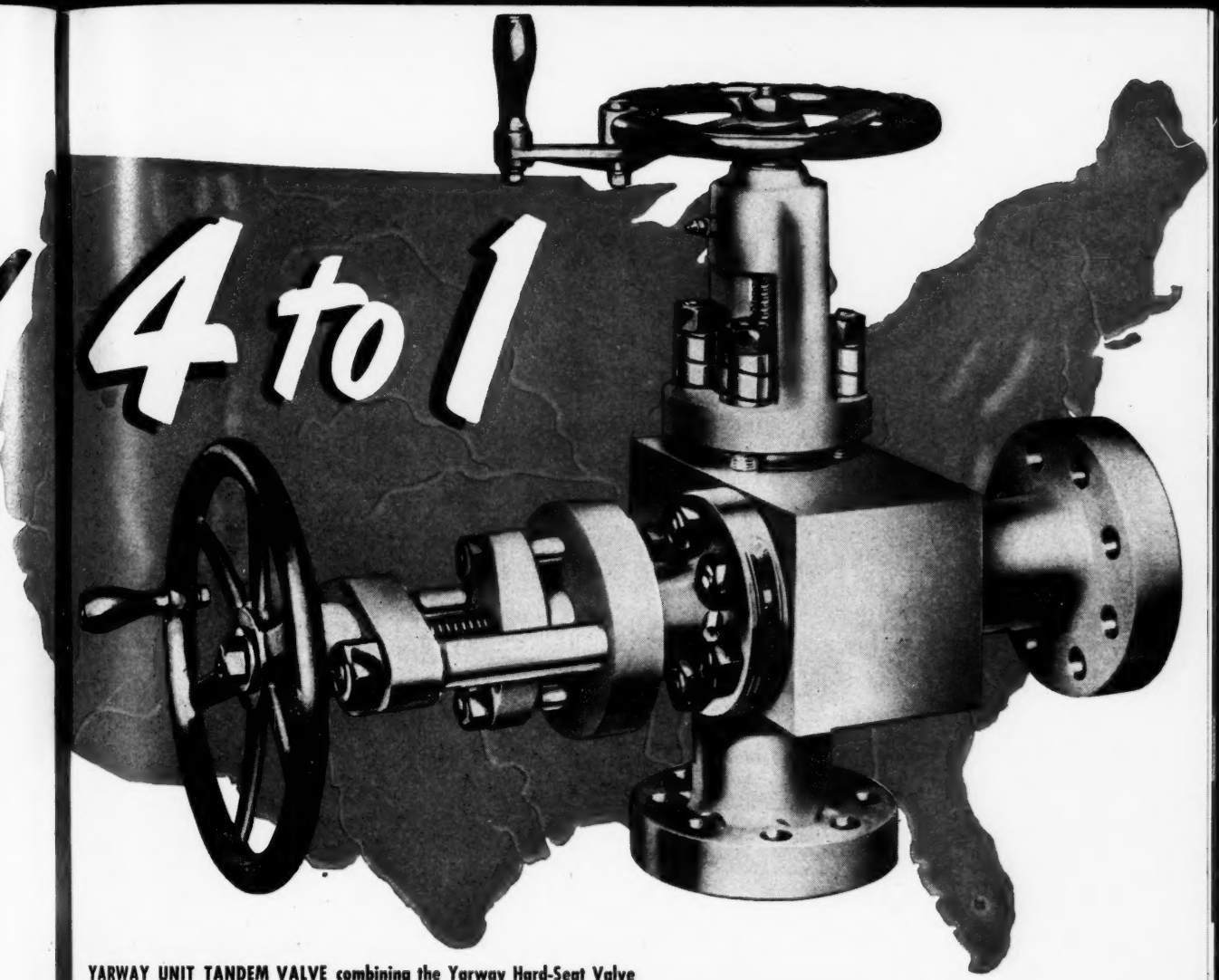
For latest information on Yarway Unit Tandem Blow-Off Valves, write for Yarway Bulletin B-432.

YARNALL-WARING COMPANY 114 Mermaid Ave., Philadelphia 18, Pa.



YARWAY TYPE "C" SEATLESS ANGLE VALVE
Open position. Notice balanced sliding plunger design. For pressures from 400 to 2500 psi.

YARWAY HARD-SEAT STRAIGHTWAY VALVE
Open position. A worthy companion to the Yarway Seatless Valve for tandem use on higher pressures. For pressures from 400 to 2500 psi.



YARWAY UNIT TANDEM VALVE combining the Yarway Hard-Seat Valve (for blowing) and the Yarway Seatless Valve (for sealing) in a single forged steel body. Flanged-type shown. For pressures from 400 to 2500 psi.

FEW OF MANY PROMINENT PLANTS EQUIPPED WITH YARWAY BLOW-OFF VALVES

Cleveland Electric Illuminating Company
Avon, Ohio

Philadelphia Electric Company
Southwark Station
Philadelphia, Penna.

Pacific Gas & Electric Company
Kern Station
Bakersfield, California

Duke Power Company
Spencer, North Carolina

Lynn Gas & Electric Company
Lynn, Massachusetts

Phelps Dodge Corporation
Ajo, Arizona

Bethlehem Steel Company
Sparrows Point, Maryland

Tennessee Eastman Corporation
Kingsport, Tennessee

Ohio Oil Company
Robinson, Illinois

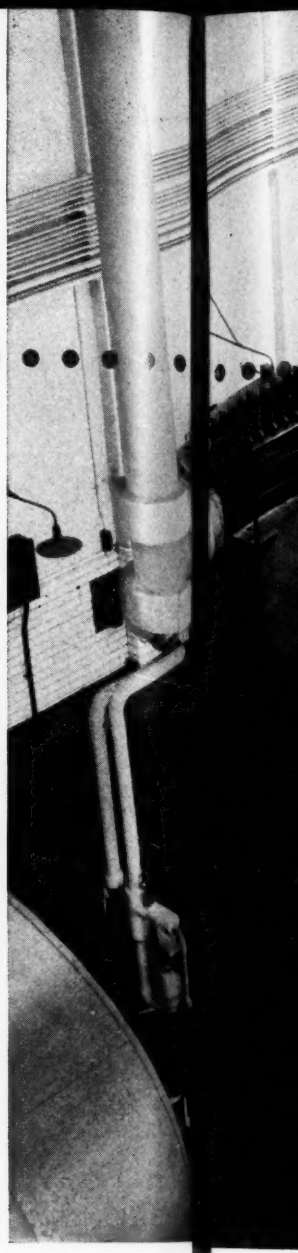
Solvay Process Company
Hopewell, Virginia

Fibreboard Products Company
East Antioch, California

Gulf States Paper Company
Tuscaloosa, Alabama

YARWAY BLOW-OFF VALVES

How's this for low-acidity operation?



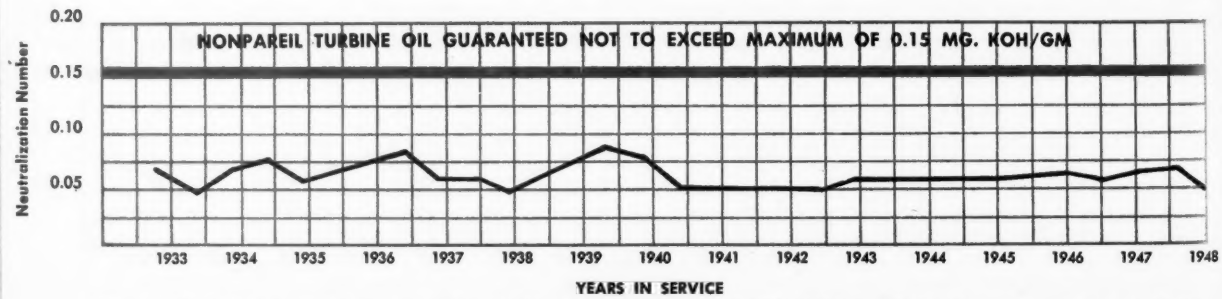
Illustrated (foreground) is the 20,000 KW turbine of the Minneapolis Street Railway Company. Also shown below is the 15-year acidity record of its lubricating oil—Nonpareil.

As you can readily see, the high point in the oil's acidity has been the extremely low neutralization number of .075 mg KOH/gm.

As a result of this low-acidity operation, there has been no oil treating, no turbine cleaning, and no oil replacement except the usual make-up oils. As another result, in 1946, when the company installed a new 15,000 KW turbine (also illustrated), the lubrication job was awarded to Nonpareil.

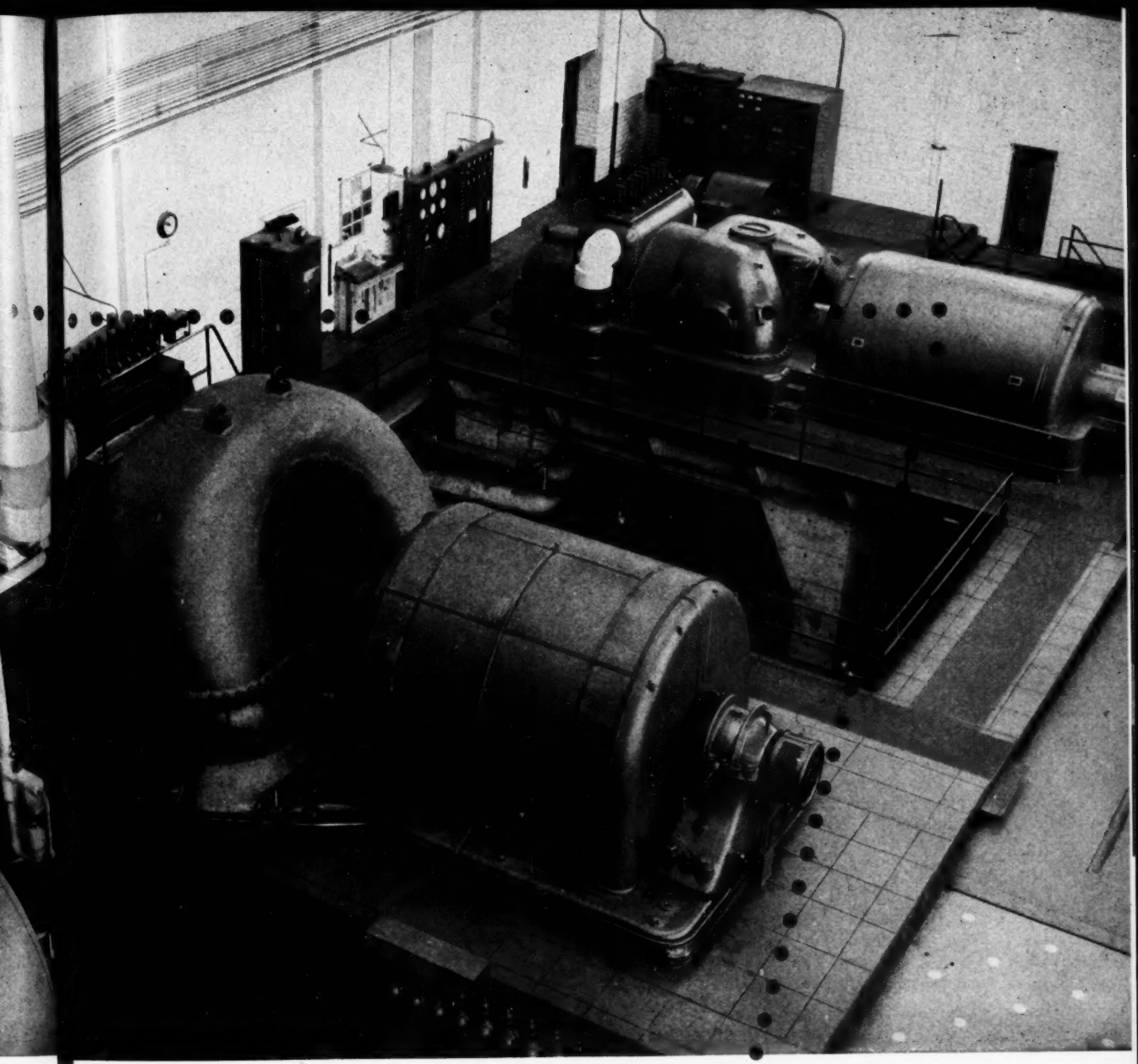
Why not assure trouble-free operation for your turbines with this different turbine oil—the only lubricant in its field that carries a written guarantee against excessive acidity.

Let a Standard Oil Lubrication Engineer explain how guaranteed Nonpareil can save you money. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.



This chart shows the neutralization number (as determined by A.S.T.M. Method D 188-27T), of Nonpareil during 15 years of operation in the 20,000 KW turbine of the Minneapolis Street Railway Company. Nonpareil is guaranteed not to exceed 0.15 mg KOH/gm for the life of the turbine.

STANDARD OIL COMPANY (INDIANA) STA

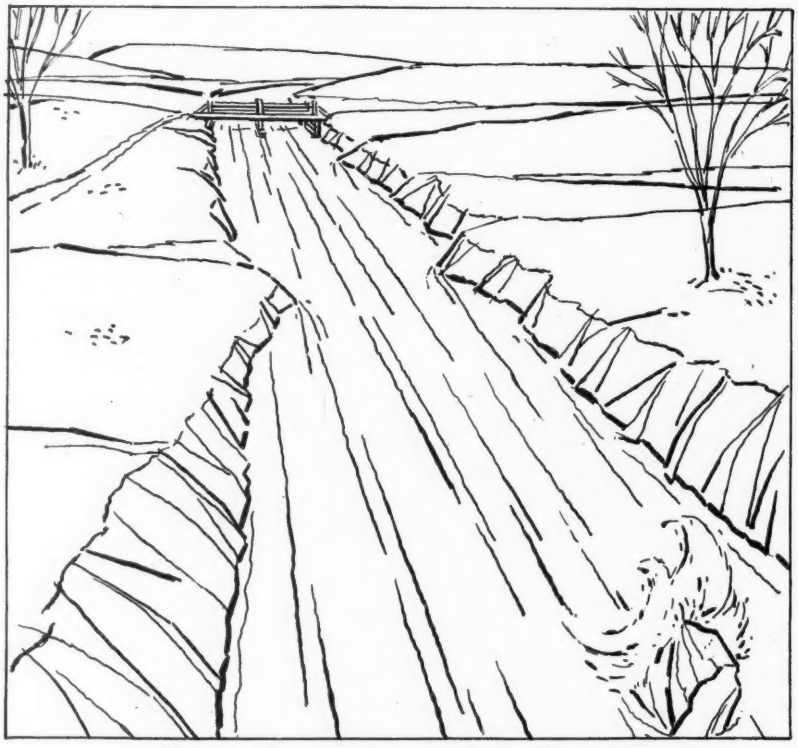


NONPAREIL
TURBINE OIL

STANDARD OIL COMPANY (INDIANA)

STANDARD

Effective water treatment



Clay—a major constituent of the earth's crust—is present in most waters as aluminum silicate.

APPROXIMATE knowledge in water-conditioning work isn't enough. It is necessary not only to know the major result of a conditioning procedure and the principal change taking place at a given stage, but also to foresee the probable indirect results.

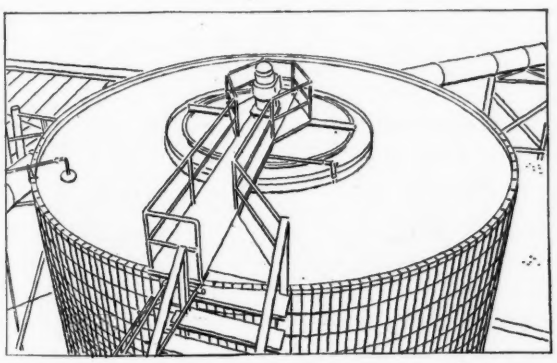
Take, for example, a typical water containing too much hardness for boiler use, but with suspended solids low enough to make preliminary filtering seem unnecessary. Only softening appears to be required.

Suppose, however, that the suspended ma-

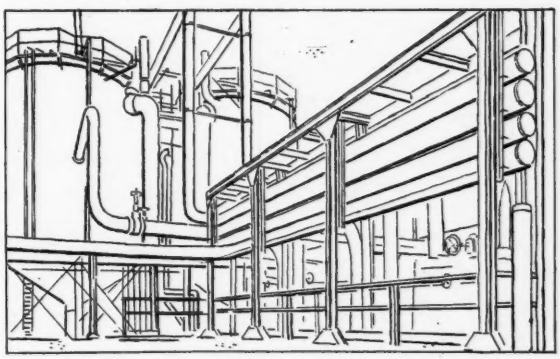
HAGAN
HALL
BUROMIN
CALGON

requires *full* knowledge

terial is clay—a source of alumina and silica —and that hot-process softening is the preferred method. With this method, water becomes hot and alkaline, and under these conditions tends to dissolve the clay. Alumina and silica then are not removed by filtering but are carried into the boiler where they may help to form scale. Cold coagulation and filtering before softening, while the clay is still unattacked, is indicated.



Cold coagulation and filtering before softening easily removes clay—a source of dissolved alumina and silica.



With prior filtration, hot-process softening develops no dissolved alumina and silica to be carried on to the boilers and cause scale.

The procedures recommended by Hall Laboratories take account of *all* factors which enter into a problem and represent the most economic and efficient solution in your specific situation.

Every problem concerning the use of water in industry comes within the scope of Hall Laboratories. Correspondence concerning such problems is invited. Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

"...we have burned about every kind of coal--wet, damp and very fine dusty coal..."

a C-E performance story

A recent service report from Mr. Walter Gaumer, Power Plant Superintendent of Keystone Steel and Wire Company, Peoria, Illinois, eloquently verifies the operating advantages inherent in the C-E Continuous Discharge Spreader Stoker. Excerpts follow:

"... we have burned about every kind of coal – that is, extremely wet coal, damp coal and very fine dusty coal, with excellent results. We have operated at all ratings from 30,000 to 150,000 lb steam per hour without smoke or clinkers and with but very little fly ash. We remove fly ash only once in 24 hours and siftings every 3 or 4 days. It is surprising what a small amount accumulates in that period.... Our overall steam costs are at least 15 to 20 per cent lower since the new unit has been in service." B-204

This report, it is true, reflects the expert handling with which Mr. Gaumer operates his equipment, but it also emphasizes unmistakably the advantages of C-E Continuous Discharge Spreader Stoker design.

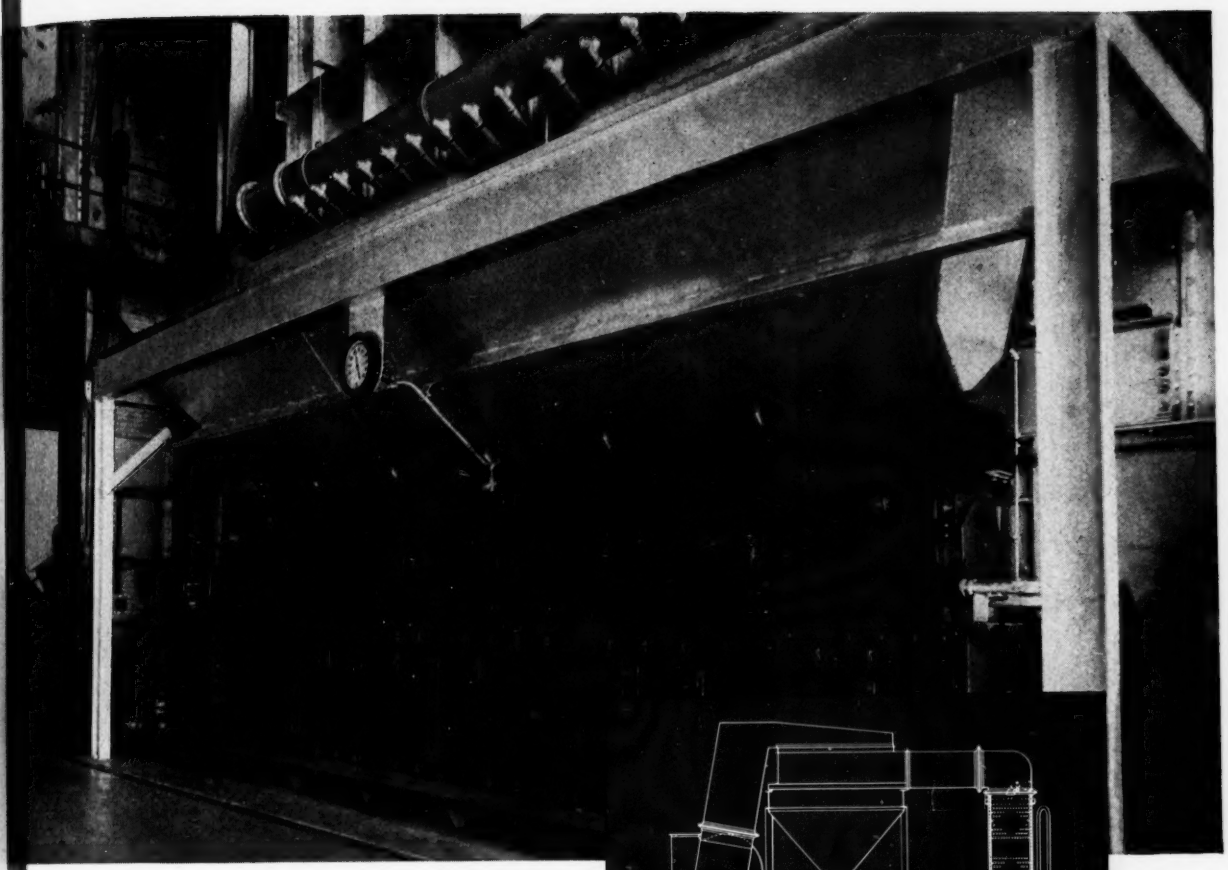
Combining the best features of spreader and travelling grate types, the C-E Continuous Discharge Spreader Stoker accommodates itself to widely varying grades of coal with a flexibility that permits close control of the fuel bed to meet any load requirements of the boiler.

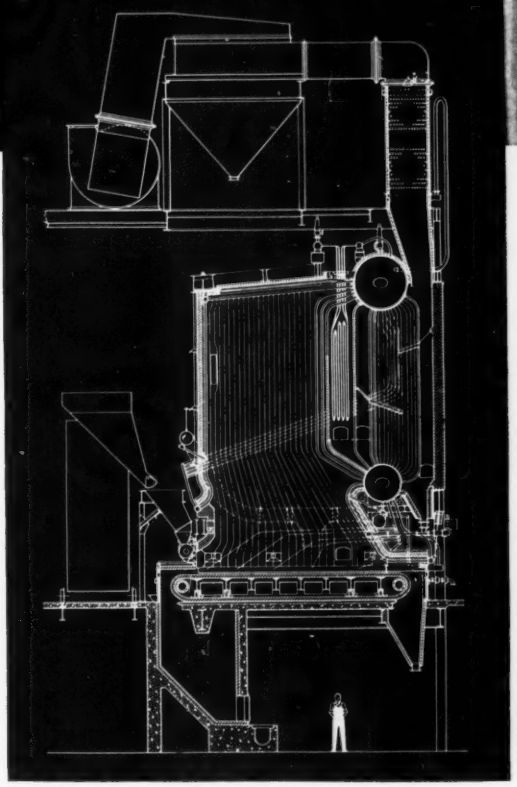
Into the C-E Continuous Discharge Spreader Stoker is built the experience of an organization that has equipped more boiler heating surface for stoker and pulverized coal firing than any other company in the world. You are invited to avail yourself of this experience in solving *your* stoker needs.

C-E

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



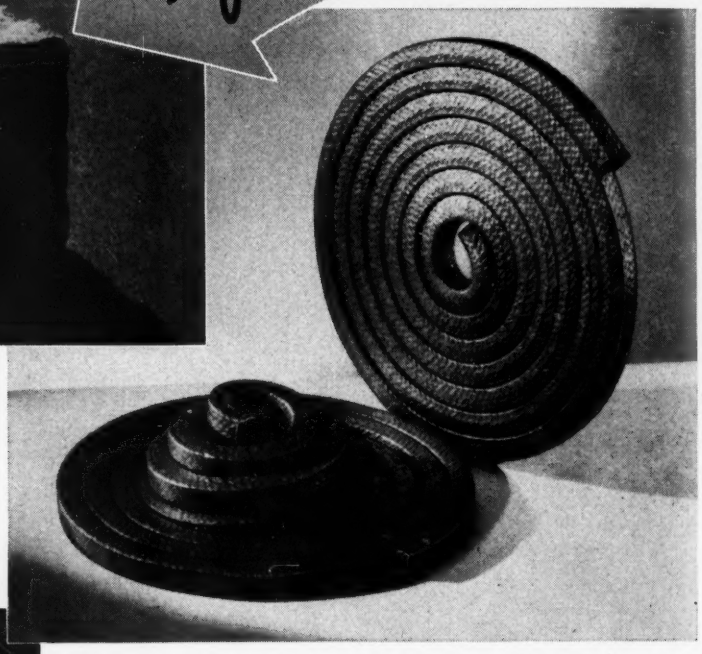


The C-E Unit illustrated above and at the right was designed and built for the Keystone Steel and Wire Company, Peoria, Illinois, and first placed in service in May, 1947. It comprises a C-E Steam Generator, Type VU, equipped with an Elesco Superheater, a C-E Economizer and is fired with a C-E Continuous Discharge Spreader Stoker. The unit is designed to produce, at maximum continuous capacity, 150,000 lb of steam per hr at 450 psi and 750 F.

ENGINEERING

200 MADISON AVENUE • NEW YORK 16, N. Y.

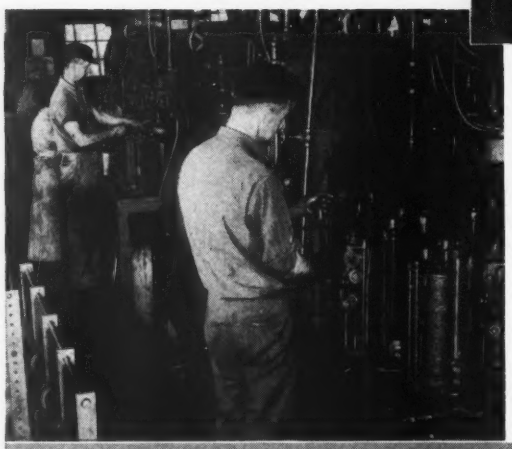
Lattice-Braided – for Longer Life



Above: Cross section view of GARLOCK *Lattice-Braid* packing, showing unique structural design. (Patented)

Right: GARLOCK 731 *Lattice-Braid* Coil.

Below: Specially designed braiding machines (exclusively Garlock) braid strands *through and through* in an entirely new and different way.



All the braided strands of GARLOCK *Lattice-Braid* packing are lattice-linked together into one structural unit. The strands hold firmly together even when the packing is worn beyond the serviceable limits of wear of ordinary braided packings. This unique structural design also provides unusual flexibility. GARLOCK *Lattice-Braid* packing is manufactured from asbestos, flax or cotton—for various types of service. Write for descriptive folder.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Montreal, Que.

GARLOCK *Lattice-Braid* PACKING

Authoritative, useful Reference Material

PERTAINING TO PIPING

Published as a service to industry by the people who pioneered in welding fittings and manufacture the leading line. Return the coupon checked for the material you want.

1 TUBE-TURN CATALOG No. 111 SUPPLEMENT
Twenty pages of specifications covering new items in the constantly expanding line of Tube-Turn* welding fittings.

2 WHY AND WHERE TO USE STAINLESS STEEL PIPING
Interesting and informative, this 24-page booklet answers the question: "Why and Where Use Stainless Steel Piping?", and discusses applicable welding processes. Well illustrated.

3 TUBE-TURN CATALOG AND ENGINEERING DATA BOOK No. 111
The 240-page volume containing a wealth of engineering information and technical data, as well as buying information covering more than 4000 welding fittings and flanges.

4 ALLOWABLE WORKING PRESSURES OF TUBE-TURN WELDING FITTINGS
Booklet of pressure tables, covering welding fittings in all sizes, all weights and all regularly manufactured materials, for Power Piping, Oil Piping, Heating Piping, Gas Piping, Refrigeration Piping.

5 FLANGE PRESSURE-TEMPERATURE RATINGS
A booklet giving you the revised ratings adopted as a war measure to utilize the full strength of Flanges, Flanged Fittings, and Valves with dimensions according to ASA B16-1939.

*T. M. REG. U. S. PAT. OFF.

6 CHART OF PIPE & FITTINGS MATERIALS
A very helpful quick-reference chart covering ASTM and other specifications, Chemistry, Service Temperature Limits and Welding Data on carbon, intermediate alloy, stainless and special analysis steels.

7 TUBE-TURN STAINLESS STEEL WELDING FITTINGS AND FLANGES
A book of technical data and buying information covering a wide range of styles and sizes of stainless steel welding fittings and flanges in types 304, 316, 347.

8 FATIGUE TESTS OF WELDING ELBOWS AND COMPARABLE DOUBLE-MITRE BENDS
A research paper presented before A.S.M.E. Analyzes effects of bending in the plane and bending transverse to the plane of curvature, and bending with and without internal pressure.

9 DIMENSIONAL DATA AND WEIGHTS
A folder of man-size tables giving you dimensional information concerning Tube-Turn welding fittings from ½" to 30" in standard weight and extra strong, and flanges in all sizes and weights.

10 VOLUMETRIC CAPACITIES OF TUBE-TURN WELDING FITTINGS
A handy booklet-giving capacities in cubic inches of Tube-Turn welding Elbows, Returns, Caps, Lap Joint Stub Ends, Crosses, Reducers, and Reducing Outlet Tees in their full range of sizes.

11 TUBE-TURN GROOVE TYPE WELDING RINGS WITH KNOCK-OFF SPACER PINS
A folder of data about a major new development for better pipe welding—a perfectly engineered welding ring that assures exact root gap spacing and complete penetration.

TUBE TURNS, INC., DEPT. 40, LOUISVILLE 1, KY.

Please send Tube-Turn reference material indicated by the numbers I have checked below. I understand there is no obligation.

1 2 3 4 5 6 7 8 9 10 11

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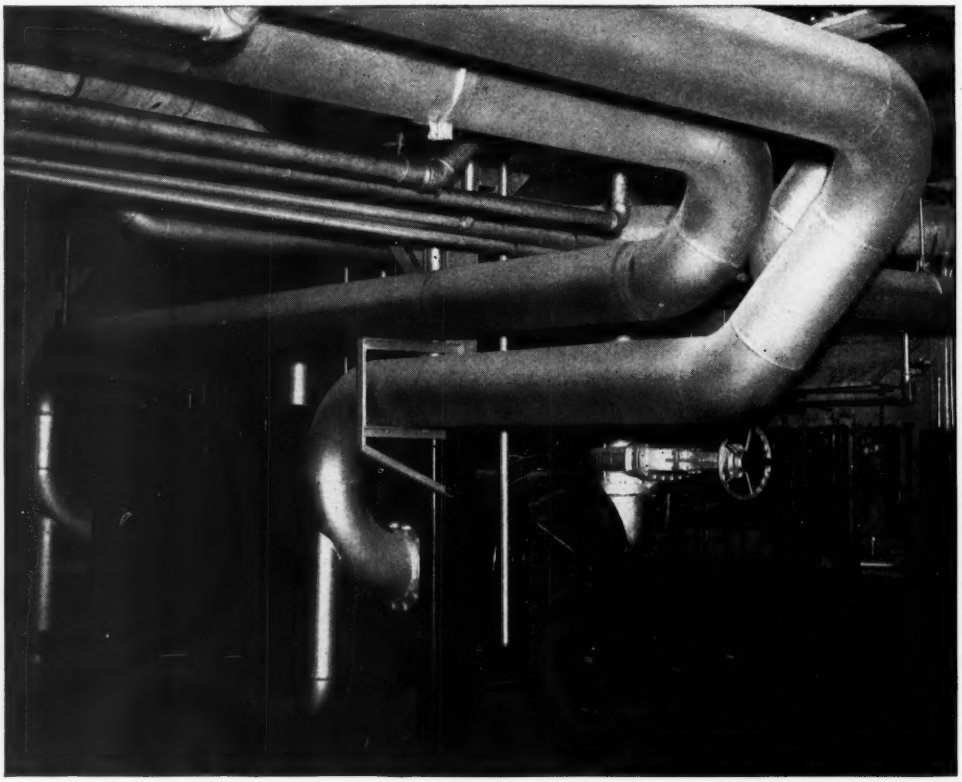
FIRM_____ Position

ADDRESS_____

CITY_____ ZONE____ STATE____



In the Power industry, Tube-Turn welding fittings provide greater safety through forged-in strength and leakproof connections, give years of trouble-free, efficient operation.

Piping Perfection for ALL Industry

When Tube Turns, Inc. pioneered welding fittings, industry at large received a multi-million dollar boost in increased piping efficiency.

Tube-Turn welding fittings add superior, *forged-in* strength to any industrial piping system. Light in weight, and forming a continuous, leakproof connection with the pipe, Tube-Turn fittings are easy to install, simplify insulation. Absence of crevices and projections within joints reduces corrosion and erosion, also facilitates flow.

Backed by the nation's foremost welding fitting manufacturing experience, Tube-Turn welding fittings—*the fittings that become part of the pipe*—are quality-controlled for dependability, are readily available in the widest range of types, sizes, metals and alloys.

In addition to more than 4000 items in grade A and grade B carbon steels, Tube-Turn welding fittings and flanges are manufactured in wrought iron, copper, Monel metal, stainless steels, carbon moly steels, aluminum, brass, Inconel, nickel.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY

District Offices at New York, Philadelphia, Pittsburgh, Detroit, Chicago, Houston, Tulsa, San Francisco, Los Angeles

TUBE-TURN

TRADE MARK REG. U. S. PAT. OFF.

Welding Fittings and Flanges

Ever see a pump any EASIER to install?

THE *Electrifugal* PUMP

IT'S A "PACKAGE" — a complete, low-cost pumping unit that meets a wide range of requirements. It can be installed in any position, and fits easily into limited space.

DRIP-PROOF MOTOR — Allis-Chalmers Lo-Maintenance design, specially built for pumping service. Stator core and windings may be replaced as a unit.

DEPENDABLE PUMP — with such long-service features as bronze wearing rings, generous packing, improved plastic water seal.

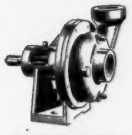
EASY MAINTENANCE Pump can be taken apart readily for inspection and replacement of packings or wearing rings, when necessary.

Many Sizes Now Available

ELECTRIFUGAL PUMPS are made in capacities from 15 to 1400 gpm, and heads to 500 ft. Many of these sizes are now in stock. Also available are some sizes of PEDRIFUGAL and SS UNIT pumps. If you need small pumps NOW, phone or wire your nearest A-C office or dealer for latest stock and delivery information.

And for general information on the complete A-C line of centrifugal pumps, up to 600,000 gpm, ask for Bulletin B6059D. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

A 2383



PEDRIFUGAL

The new A-C pump for flexible Texrope V-belt drive. Capacities to 500 gpm, heads to 100 ft.

SS UNITS

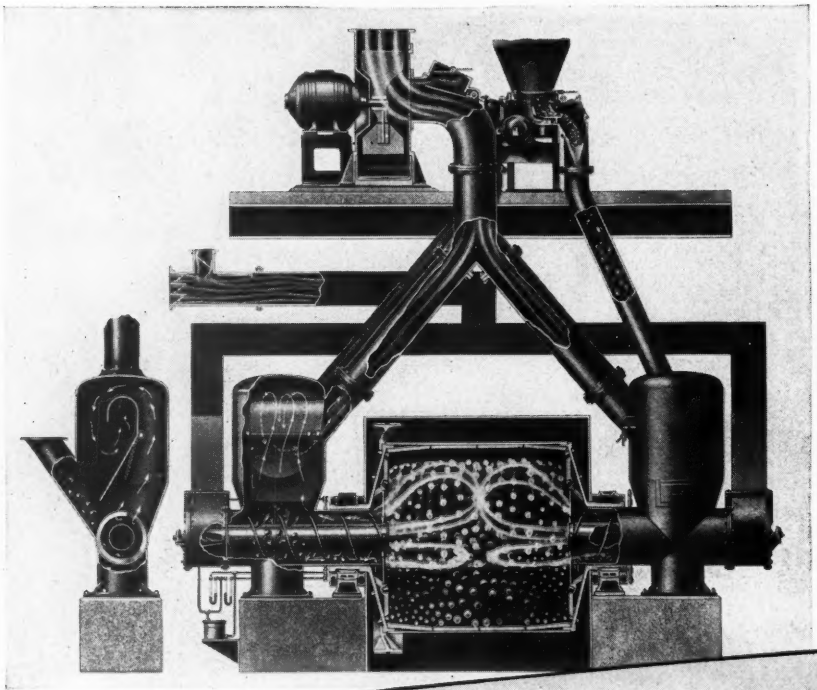
Close-coupled pump and motor units, made in 234 standard ratings, to 2500 gpm.

Electrifugal, Pedrifugal, SS Unit and Texrope are Allis-Chalmers Trademarks.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

The FW Ball Mill pr



One of the best methods for pulverizing fuels, especially those of a hard or abrasive nature, is the ball mill. The FW ball mill pulverizer represents fifty years of experience with pulverized fuels plus the knowledge and engineering skill gained in making many important installations. FW ball mills incorporate a high degree of efficiency, availability and economical operation.

Outstanding features!

1. Large Reserve Capacity
2. High availability — Low maintenance
3. Constant Fineness
4. Successful installations for pulverizing
   a. Anthracite Coal
   b. Bituminous Coal
   c. Coke breeze
   d. Lignite
   e. Petroleum coke
5. Systems with all component parts
6. 50 years background

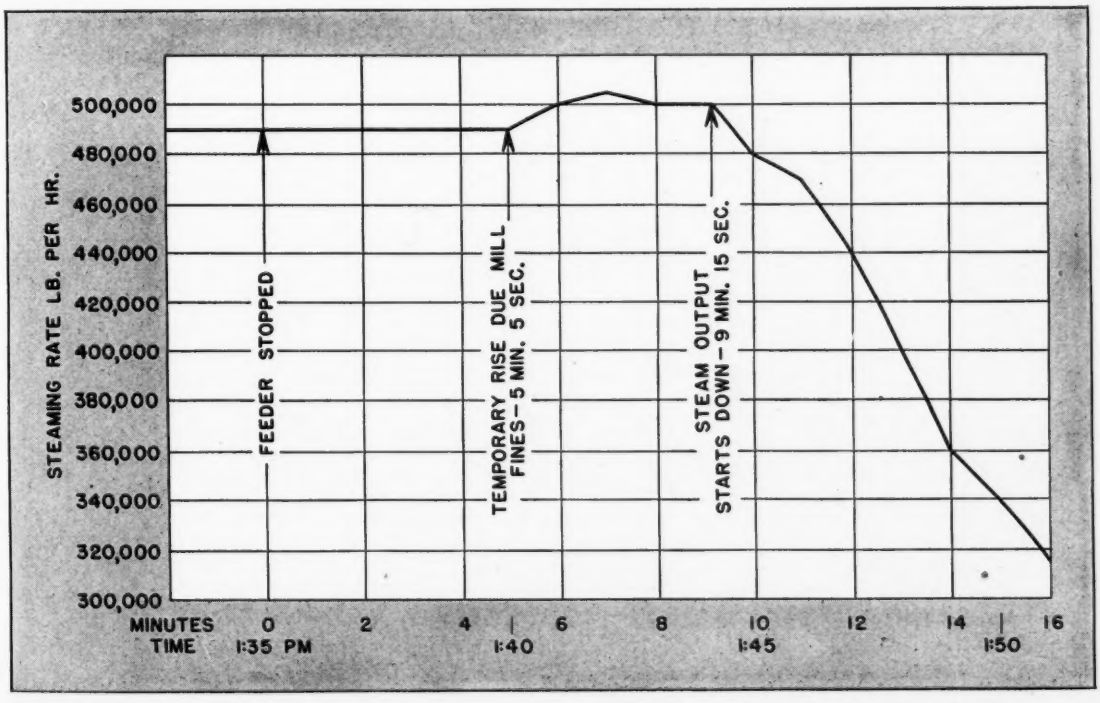
l provides reserve capacity

1 A single Foster Wheeler ball mill pulverizer will produce a steady supply of pulverized fuel without the necessity of standby pulverizers. A large reserve supply of fuel in the Foster Wheeler ball mill is always available to maintain smooth, uninterrupted operation of the steam generating equipment, regardless of the rapidity or extent of load change.

Feed interruptions up to about 10 minutes duration do not affect the capacity of the steam generator. The figure below is a typical result of a test run on one of two ball mill pulverizers firing a large steam generator. In this case, the feeder of one of the two mills was stopped with no other changes made in the operating adjustments. The original steaming rate was maintained for 9 minutes. In fact, 5 minutes after the raw coal feed was discontinued, the capacity increased slightly, due to finer pulverization of the remaining fuel. After 9 minutes, the steaming rate slowly decreased until all fuel in the one mill was depleted and all steam from the boiler was being produced by fuel from the other mill.

The usual causes of feed interruptions, such as hang-up of fuel in the bunker, may be corrected within a short time. Within that time, no drop in capacity, or hazardous loss of ignition, with re-ignition, occurs.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, NEW YORK



FOSTER WHEELER CORPORATION

For maximum *flexibility*

the Hagan Differential Master system

Until a very few years ago, virtually every boiler installation was designed for a single fuel. There was no question, in a given area, as to what fuel would be used by plants in that area.

Today, study of the fuel situation is usually one of the first steps in designing a steam plant. In an increasing number of cases, it is found that, for maximum fuel economy and for insurance against fuel shortages, the installation should be flexible enough to permit the use of two, three or even more fuels. In some installations these fuels are used singly; in others, it may be necessary to burn two or more fuels together in varying combinations.

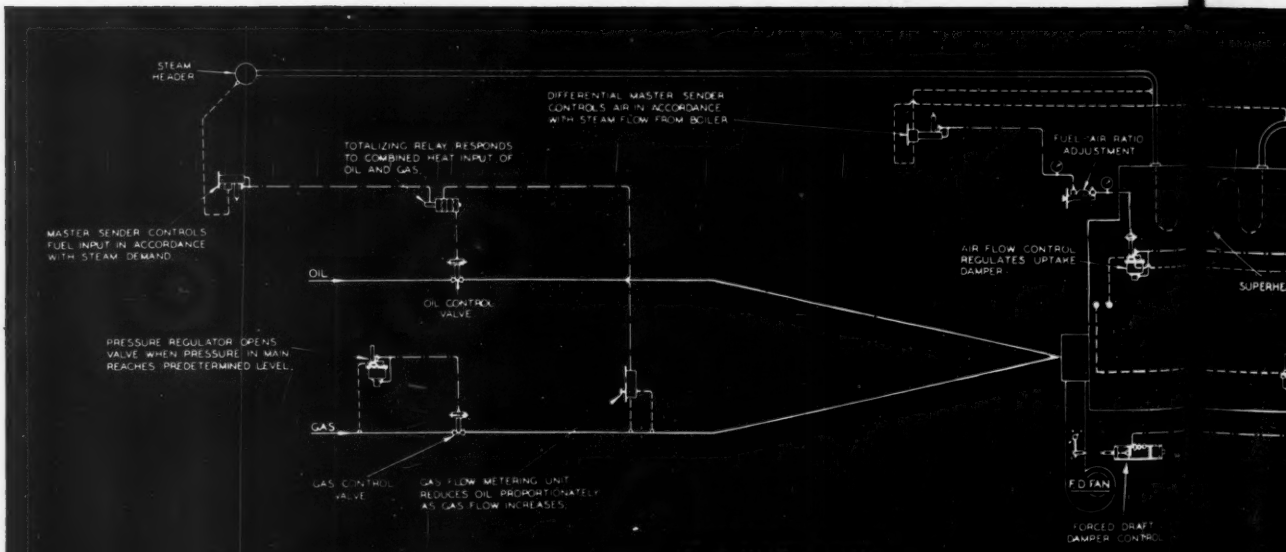

STEAM HEADER
DIFFERENTIAL MASTER SENDER CONTROLS AIR IN ACCORDANCE WITH STEAM FLOW FROM BOILER
TOTALIZING RELAY RESPONDS TO COMBINED HEAT INPUT OF OIL AND GAS
FUEL-AIR RATIO ADJUSTMENT
MASTER SENDER CONTROLS FUEL INPUT IN ACCORDANCE WITH STEAM DEMAND
AIR FLOW CONTROL REGULATES UPTAKE DAMPER
OIL
OIL CONTROL VALVE
PRESSURE REGULATOR OPENS VALVE WHEN PRESSURE IN MAIN REACHES PREDETERMINED LEVEL
GAS
GAS CONTROL VALVE
GAS FLOW METERING UNIT REDUCES OIL PROPORTIONATELY AS GAS FLOW INCREASES
F.D. FAN
FORCED DRAFT DAMPER CONTROL

DIAGRAM OF CONTROL SYSTEM USED IN REFINERY. WASTE GAS IS BURNED AS AVAILABLE; AUTOMATICALLY SUPPLEMENTED OR REPLACED BY OIL AS NECESSARY.

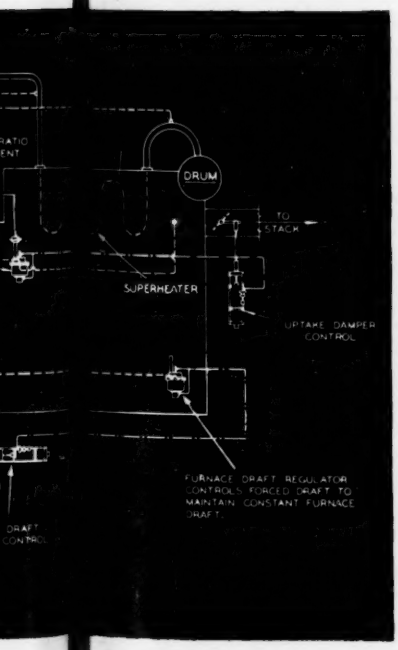
in the use of fuels

of automatic combustion control

The key to maximum flexibility in the use of fuels is the Hagan Differential Master system of automatic combustion control.

With this system, excess air is correctly and automatically controlled at all times. You can burn gas, oil, coal or any combination of these fuels; the B.t.u. value of each may fluctuate; coal may be dry or wet, large or small, screened or run-of-mine—but excess air is kept constant.

This is accomplished simply and directly. A *Master Sender,* sensitive to steam header pressure, controls the rate of fuel feed so that B.t.u. input is in accordance with demand. A *Differential Master Sender,* measuring steam flow, regulates air flow.



Each of these units has its own function, and performs that function *directly.*

The rate of fuel feed is changed instantly to compensate for any change in steam demand, for any fluctuation in calorific value of fuel, or for any variation in feeder characteristic.

Air, however, is changed *only when there is an actual change in heat input to the furnace, as shown by a change in steam flow.*

The Hagan Differential Master system will help you meet changing fuel situations in the future—and right now it will give you better control of combustion and substantial fuel savings. Our engineers will be glad to discuss its possibilities in your plant.

HAGAN
HALL
BUROMIN
CALGON

Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN CORPORATION

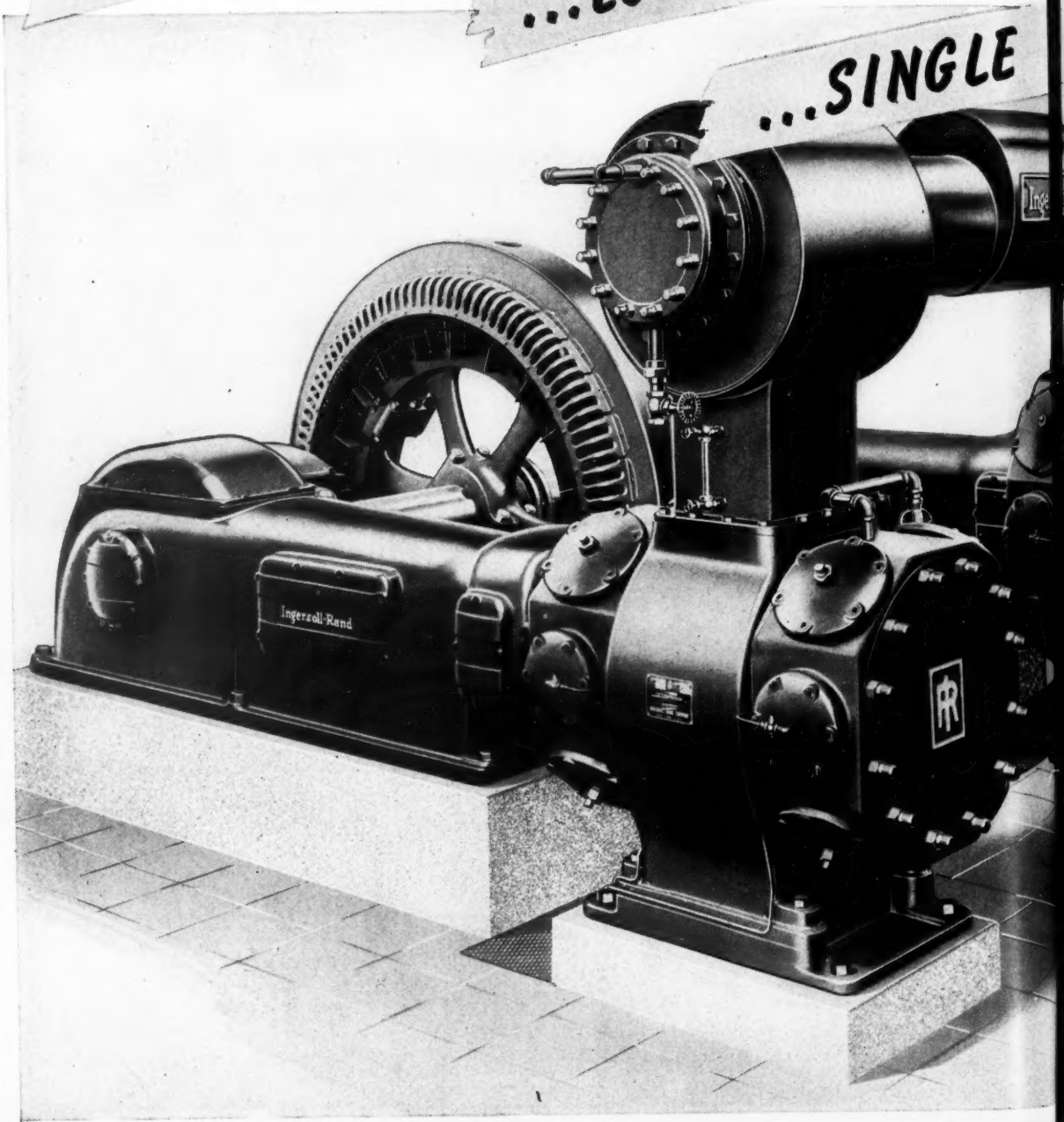
BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

RUBILENE OILS . . . f

...LARGE and SMALL

...LOW PRESSURE a

...SINGLE -S

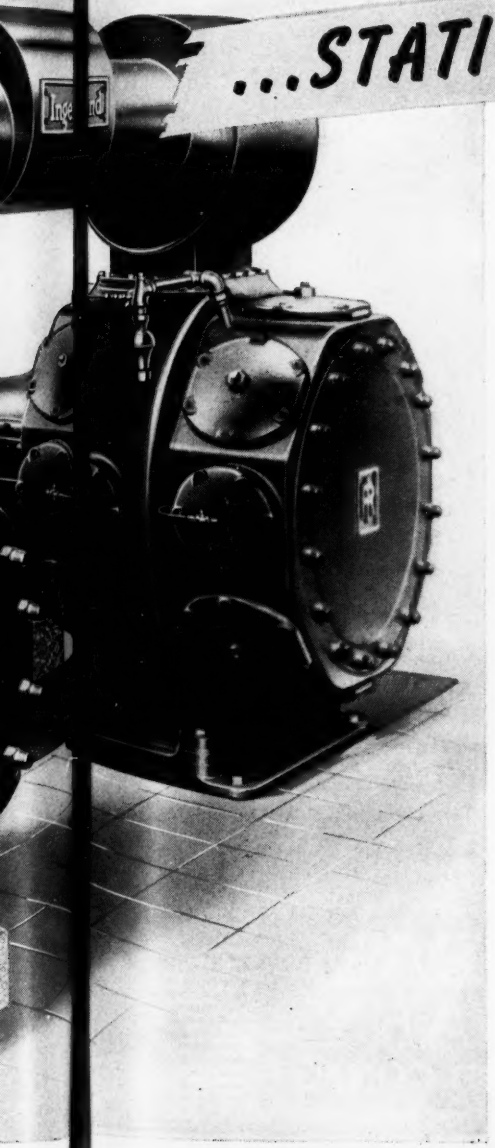


. . . for Air Compressors

and HIGH PRESSURE

-STAGE and MULTIPLE-STAGE

...STATIONARY and PORTABLE



Regardless of size or classification, assured, uninterrupted performance of air compressors depends largely on lubrication. High stability and oxidation resistance are necessary qualities of a compressor lubricant to protect against the problems of carbon formation and sticking valves.

Every grade of Sinclair RUBILENE is always fully refined to meet these requirements. Whether of low viscosity or heavy body, RUBILENE is always top quality, always uniform.

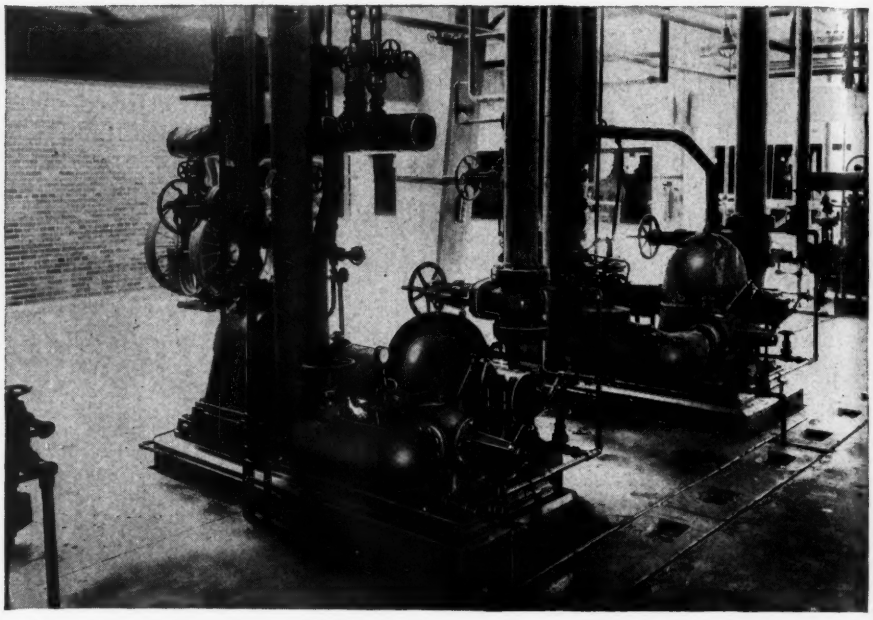
Write for expert consultation on the use of rugged RUBILENE for all compressors.

SINCLAIR

INDUSTRIAL OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVE., NEW YORK 20, N. Y.

TERRY



THE ROTORS OF THESE 75 H. P. TERRY TURBINES ARE DOUBLE RIM PROTECTED

The two 75 H.P. Terry Turbines shown above (in the plant of a leading refiner) employ the Terry Solid Wheel Rotor. The wheel is made from a single steel forging and the buckets are milled directly into the wheel. — All as shown in the illustration at the left.

The buckets are protected by rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the clearance became reduced.

With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

This feature and many others of the Terry Wheel Turbine are fully discussed in our Bulletin S-116.

T-1169

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

DEARBORN OFFERS A

Comprehensive Manual

OF WATER TEST METHODS

Over two years of careful compilation and exacting preparation are incorporated in this information-packed manual covering all water test procedures required for chemical control of water treating processes.

The manual is loose-leaf, ideal in complete form for reference or available by individual bulletins or groups as outlined in the contents reproduced below.

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Sulfite, "SO_3"
Free Carbon Dioxide, "CO_2"
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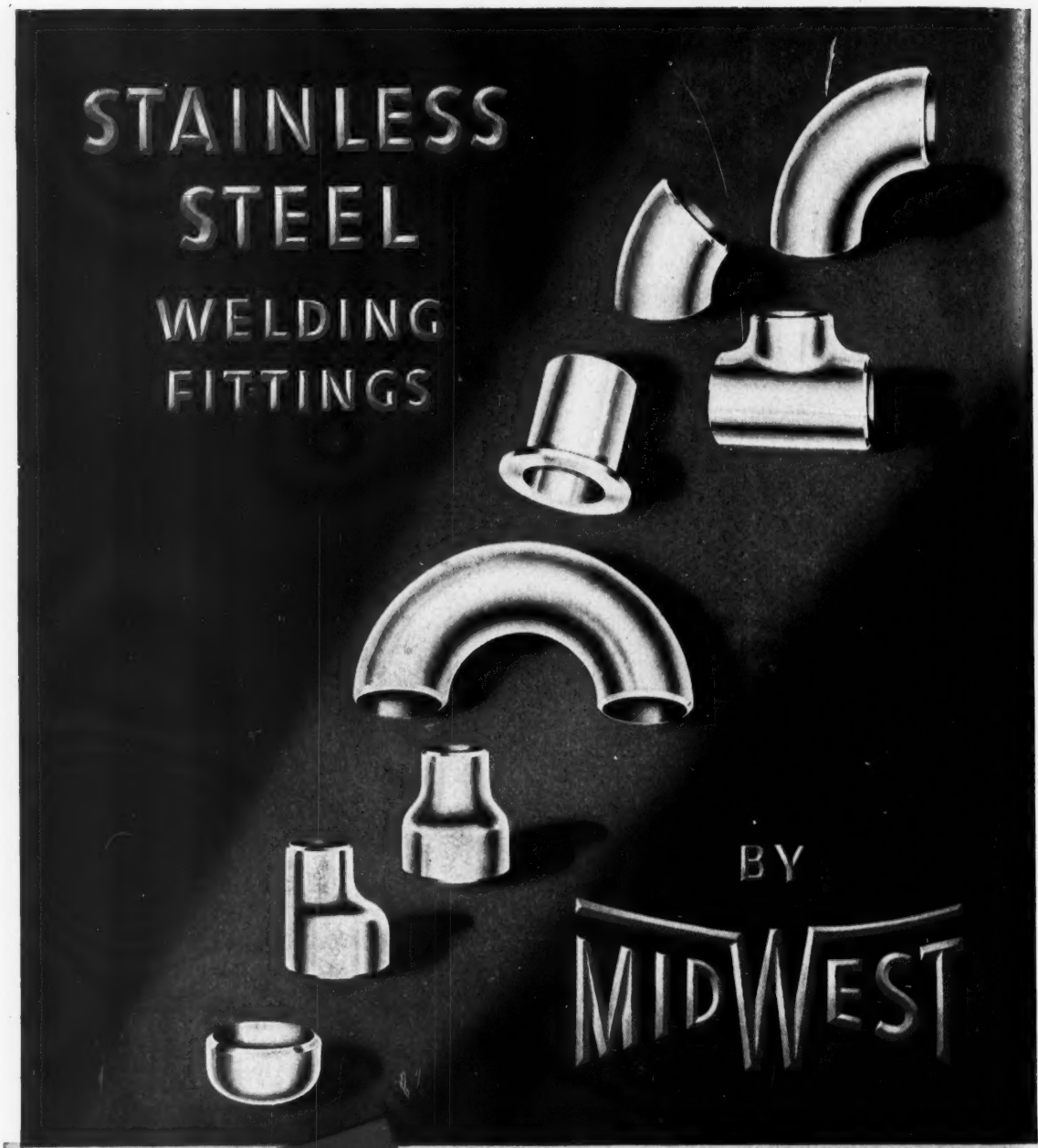
STAINLESS STEEL WELDING FITTINGS



BY MIDWEST

WRITE FOR NEW BULLETIN 47-1

Just off the press, this bulletin gives dimensions, weights, list prices, analyses, etc. of Midwest Stainless Steel Welding Fittings. Ask nearest distributor or any Midwest office.

3174

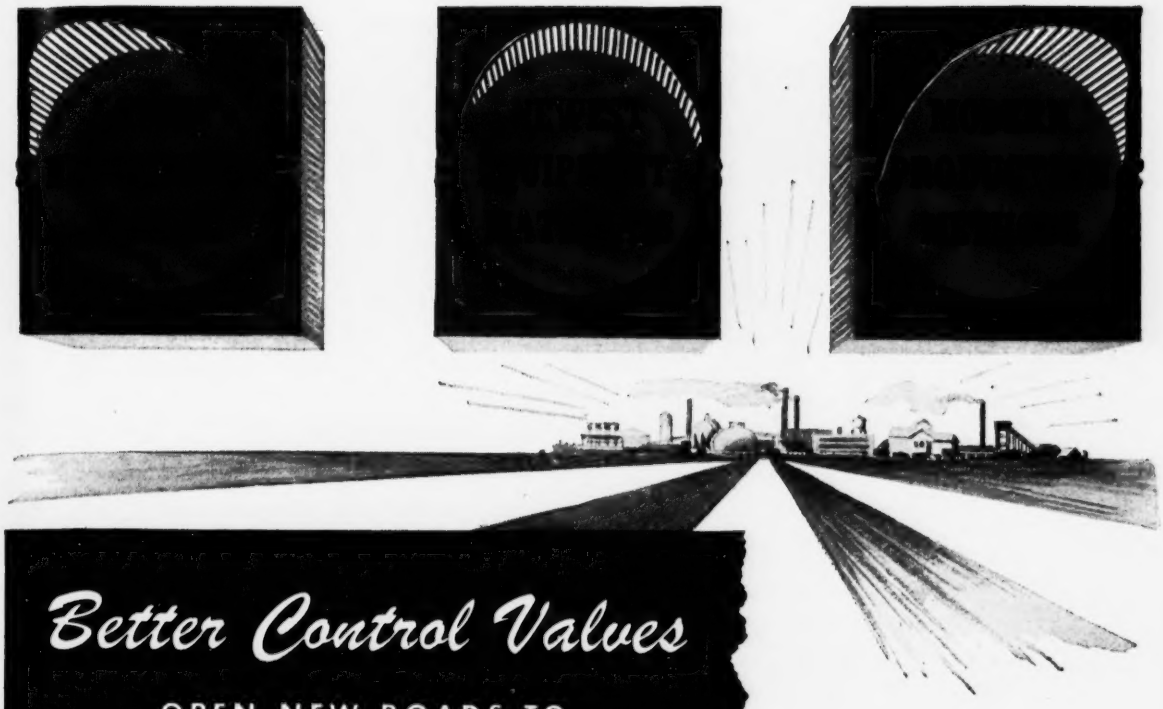
Illustrated here are the various standard Stainless Steel Midwest Welding Fittings. Types 316 and 347 are carried in stock; type 304 and other analyses can be furnished on order. Fittings are hot formed, annealed and pickled; they conform with ASA Specifications for Steel Butt-Welding Fittings.

MIDWEST PIPING & SUPPLY CO., Inc.

Main Offices: 1450 South Second Street, St. Louis (4), Mo.

***Sales Offices:* New York (7), 30 Church St.**
Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Andersen St.
Houston (2), 29 Shell Bldg. • Tulsa (3), 533 Maye Bldg.
South Boston (27), 426 First St. • Distributors in Principal Cities.

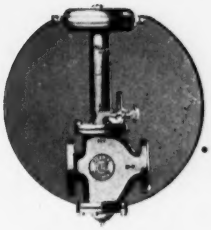
MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS



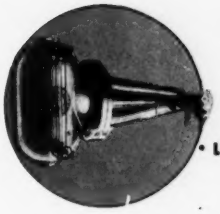
Better Control Valves

OPEN NEW ROADS TO

Better Processing



• Diaphragm Valves



• Liquid Level Controls

• Pressure Pilots

. . . and related equipment for steam, gas, air and liquid services.

With the *new* K & M regulators the process industries get a green light to more accurate, trouble-free control of pressures, flows, temperatures, and liquid level.

The reason is simply this: *K & M engineers* were given a green light when the line was designed. "Forget what's been done in the past," they were told. "Produce something better . . . to meet the process industries' needs *today.*"

Kontrol Motor Regulators are their answer. *New* light weight. *New* diaphragm materials. *New* accuracy. *New* speed in getting at the diaphragm for inspection—for (typical of the K & M approach) better design has done away with casing bolts, considered "necessary" for years!

Kieley & Mueller engineers combine the most up-to-date equipment offered today with their company's half-century background of experience. They are eager to apply this combination to the solution of your control valve problems, new installations or replacements.

Write for the new K & M catalog and names of Kieley & Mueller representatives from coast to coast.

KONTROL MOTOR

NORTH BERGEN N.J.

. . . but totally different at the crank shaft

Boiler feed and other high pressure services reach a new high in efficiency and a new low in cost when Worthington Triplex Power Pumps put the pressure on.

WHICH DO YOU NEED?

Whether you require the constant stroke of the VTE or the variable capacity of the Variflo, you get such efficiency-increasing, cost-lowering features as: totally enclosed power end; pressure lubrication on all bearings except the flood-lubricated main bearings; simple construction without reduction gears; patented flange and screw-type gland; full accessibility to plungers, valves and running parts. A complete range of sizes covers capacities up to 165 gpm in single units.

HOW VARIFLO DIFFERS

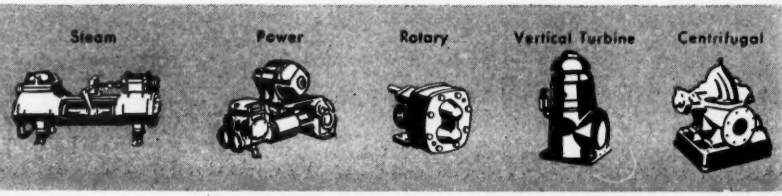
Worthington Variflo Triplex Power Pumps give you automatic, stepless capacity control from 0% to 100% at constant speed. The simple, rugged stroke-changing mechanism, carried in the crank shaft, is the only difference between Variflo and VTE.

Bulletins, describing how Worthington Triplex Power Pumps achieve dependable operation at minimum costs, prove that *there's more worth in Worthington*. Write for them to *Worthington Pump and Machinery Corporation, Reciprocating Pump Division, Harrison, N J.*

WORTHINGTON

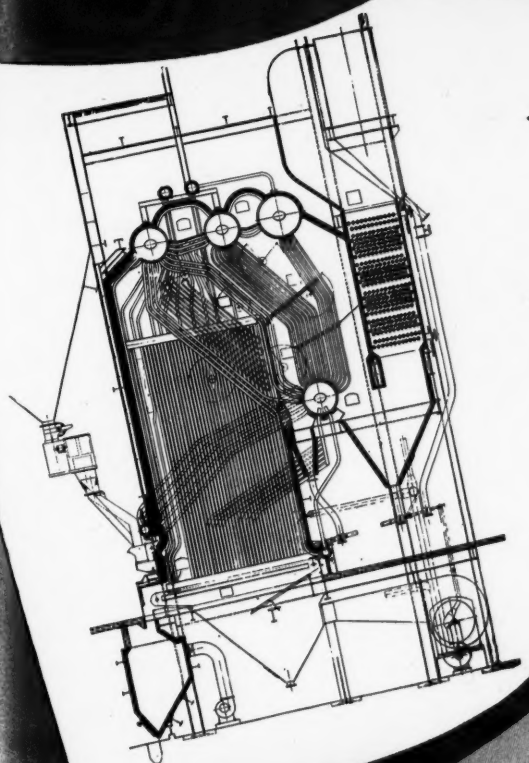
P7-2

THE WORLD'S LARGEST MANUFACTURER OF PUMPS



WICKES HELPS MAINTAIN

high quality of paper board



This Wickes 4-Drum Boiler contributes its high efficiency to the manufacture of quality paper board at the River Raisin Paper Co., Monroe, Michigan. It is a unit in the power generating system designed and coordinated by Cummins & Barnard, Inc., Consulting Engineers, Ann Arbor, Michigan. Specifications include 180,000 lb. steam per hour capacity, design pressure 700 psi, and total temperature 750° F. We build and design boilers of all types up to 250,000 lb. steam per hour and 850 psi, and are always glad to cooperate with engineers in the development of equipment for specific projects.

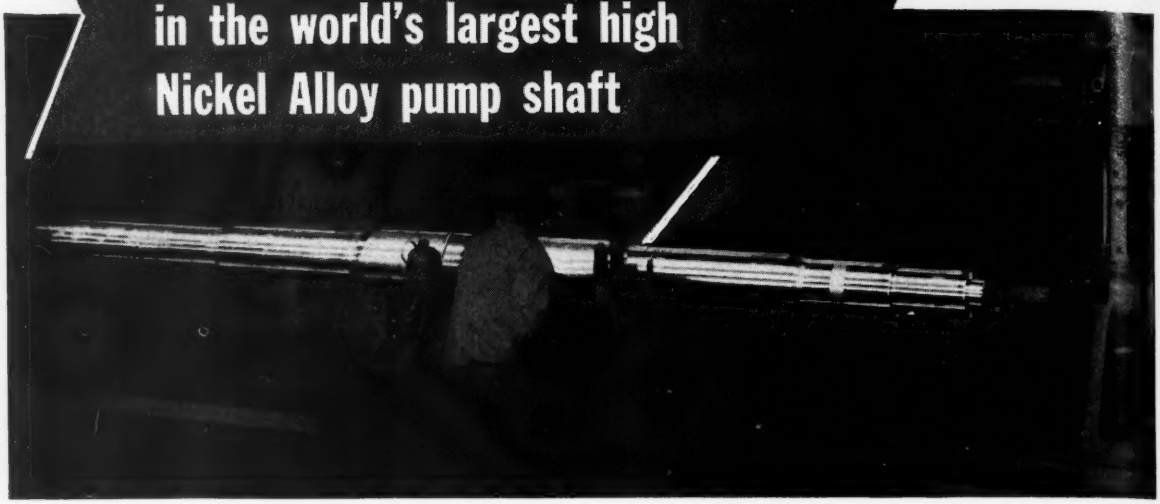
SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cincinnati • Denver • Detroit • Houston • Indianapolis • Kansas City • Los Angeles • Milwaukee • New York City • Peoria, Ill. • Pittsburgh • Saginaw • San Francisco • San Jose, Calif. • Seattle • St. Louis • Tulsa, Okla. • Mexico City, Mexico.

THE WICKES BOILER CO.

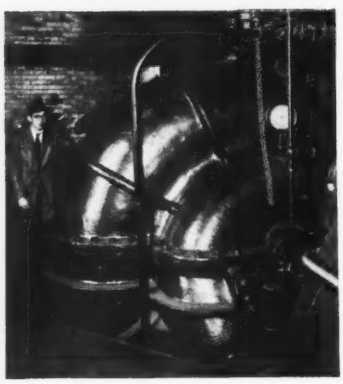
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854

Why Consolidated Edison invested in the world's largest high Nickel Alloy pump shaft



World's largest high nickel alloy pump shaft. It was forged at INCO's Huntington, W. Va. mill, and machined by the Ingersoll-Rand Company, Phillipsburg, N. J. The forging weighed 3343 pounds. The shaft's finished dimensions were: length, 13 ft. 7⅛ in.; diameter, 9.005 in.



One of two huge centrifugal pumps installed at the 14th Street plant of the Consolidated Edison Company of New York. The pumps were built by the Ingersoll-Rand Company.

In the 14th Street plant of the Consolidated Edison Company of New York, there are two large condenser circulating pumps. They are giants of their kind, together handling 160,000 gallons of water every minute. But for 19 years, they have been ailing. The cause of their malady is the polluted salt water they pump from New York's East River. Corrosive action, plus fatigue caused repeated failures of the pump shafts.

The shafts originally installed were mild steel. These failed in relatively short time, and were replaced by others of the same metal. When these, too, failed, alloy steel shafts were tried. But these fared little better, and Consolidated Edison engineers decided the time had come to stop experimenting with metals that were not sufficiently resistant to corrosion and fatigue.

From their own experience with Monel* shafts in smaller pumps, and knowing that Monel and "K"* Monel are U. S. Navy standard metals for salt water pump shafts, the Consolidated Edison Company selected "K" Monel for this important job. This heat treatable grade of Monel provides extra strength, stiffness, and hardness for bearing surfaces.

The Consolidated Edison Company expects long and trouble-free service from this new shaft, because **MONEL** has the necessary combination of properties to withstand severe stress-corrosion conditions. **MONEL** is rustproof, corrosion-resistant, tough, and stronger than most structural steels.

INCO Nickel Alloys can extend the life of your pumps, valves, gaskets, packing, tanks, heat exchangers, and other equipment. For help in solving your power plant corrosion problems, write for "Individualized INCO Nickel Alloys." It is free.

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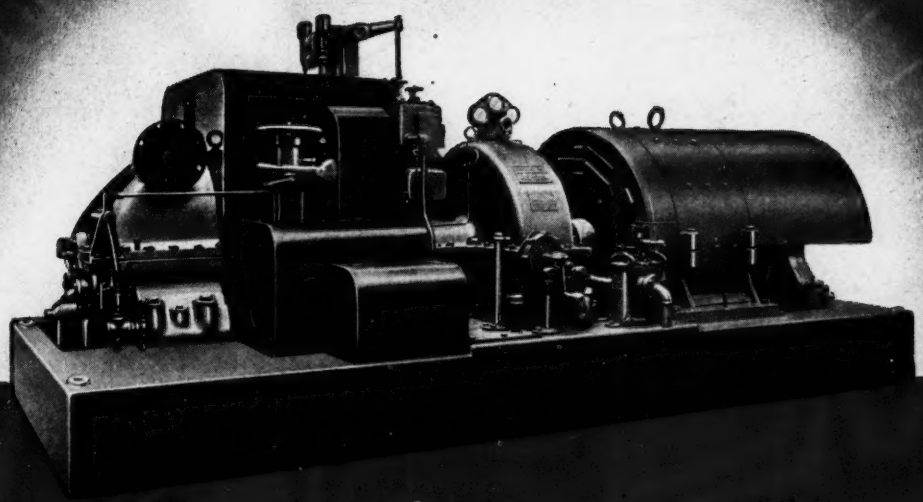

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HELPFUL BULLETINS

BOILERS, ACCESSORIES

1 **Steam Boiler Unit**—This complete automatic steam boiler unit is described in Bulletin No. 503, 4 pages. Complete specifications and dimensions are listed. Photographs show the boiler from many angles. Discussed are the waterback design, the standard equipment, the boiler and the burner, the operating and safety controls and the special equipment. Johnston Bros., Inc.

2 **Boiler Water Level Control**—Bulletin 475, 8 pages, describes the boiler water level control at Hammermill Paper Co. General layout of the No. 2 power plant is shown, and a diagram indicates the combustion engineering type steam generator that is used. Photographs illustrate typical sections of the plant using various type regulators. Significant data for two boilers is listed. Text describes operation of the plant. Northern Equipment Co.

3 **Boiler Feedwater Treatment**—Two installation photographs, which show how to apply this treatment in each installation are featured in this 4-page bulletin. It is explained in the text how the treatment stops scaling and calcification, caustic embrittlement, corrosion, foaming and priming. An explanation is given of the action that the treatment has upon boiler feedwater. Illinois Water Treatment Co.

ELECTRICAL

4 **Floor Box-Service Fittings**—Catalog No. 553 is a 4-page illustrated review of a floor box and service fittings for light, power, telephone, signal and bell system floor convenience outlets. The installation of the steel floor box with brass top is illustrated and completely described. The high and low potential service fittings are pictured and their use with the floor box is reviewed. National Electric Products Corp.

5 **Communication Equipment** — This new point-to-point radio communication equipment is described in Booklet B-3945. The 8-page booklet shows the adaptability of the Westinghouse type MV equipment to cover all radio communication demands by offering all these types of service from one transmitter. The center spread chart illustrates the inherent "building-block" design, by which only those units needed to perform specific tasks need be incorporated in any final assembly. Westinghouse Electric Corp.

6 **Mercury Vapor Lamps**—Sixteen types of mercury vapor lamps are described in this 24-page booklet, A-5112. Booklet contains detailed information on electric discharge through vaporized mercury; technical data for the 16 types of vapor lamps available; spectral radiation characteristics of vapor lamps at different arc pressures; auxiliary equipment available; operating characteristics of vapor lamps; lamp construction; lamp life and lumen maintenance; effect of ambient and lamp temperatures on lamp life; and application information. Westinghouse Electric Corp.

7 **Solenoid Contactor**—Bulletin 4451, 4 pages, fully describes and illustrates a new size 1 ac solenoid contactor of 25 amp. In addition to its application, its construction is explained; its features are detailed; its ratings are listed; its main and auxiliary contacts are explained; and its maintenance is outlined. The dimensions are shown by a group of two drawings. Ward Leonard Electric Co.

8 **High Current Resistors**—There are 8 pages in Bulletin 35, which pertains to three forms of high current resistors. The bulletin illustrates and describes the various types of ribbon resistors available for high current applications. It also contains useful data about their resistance values, current carrying capacities, dimensions, methods of mounting, etc. Ward Leonard Electric Co.

9 **Capacitors**—This line of low-voltage industrial capacitors for power factor correction is described in 28-page Catalog No. 50. Included is a description of the unit-cell box type capacitors together with illustrations and listing of the various types, as well as dimensional drawings. Data is given for installation purposes, including typical wiring connections, and recommended switch and fuse sizes for use with capacitors. To determine the amount of kva correction required, three tables are included which give power factor multipliers, approximate kva in capacitors needed to improve the power factor of representative squirrel-cage induction motors and approximate operating characteristics of representative squirrel-cage induction motors. Booklet closes with a power factor correction data request form and a guide for the application and operation of low voltage industrial capacitors for power factor correction. Sprague Electric Co.

10 **Supervisory Systems** — Featured in this 16-page catalog is a description of a printing recorder which automatically prints a complete log of all station operations. Photographs are shown of various sections of the recorder, and a typical section of recorder chart is included. Wiring diagrams of the basic three-wire circuit, of the power plant supervisory systems, are shown, as is a schematic drawing of a typical layout. Also described is a line of annunciators with photographs of the units. Autocall Co.

11 **Network Transformers**—The construction, operation and application of these transformers is described in 24-page Bulletin 61B6152A. Bulletin explains how an ac network system is operated. A full page drawing outlines the operation of this system in a large city. This is followed by description and illustration of the workmanship that goes into the manufacture of the core, coils, tap changer, bushings, tank construction and mechanism. A drawing indicates the separate switch and terminal compartments features. A number of drawings and tables, giving specifications and engineering data, complete the booklet. Allis-Chalmers Mfg. Co.

VALVES, TRAPS

12 **Valve Bulletin**—A line of balanced, pilot, butterfly, float and motor operated valves is described in this 16-page bulletin. Engineering data includes drawings of the various type valves, together with a description of their operation and applications. Complete dimensional tables and price lists are included. Davis Regulator Co.

13 **Valves**—Bulletin 615, 4 pages, describes a line of corrosion-resisting valves and angle valves and shows their internal construction by means of cutaway views. The bulletin provides complete dimensional data on the various sizes and includes an illustrated parts list. The folder also tells how the valves can be equipped with air operated diaphragm motors for automatic regulation of the flow of corrosive solutions. The Duriron Co., Inc.

14 **Butterfly Valves**—Catalog A, 60 pages, is an excellent engineering manual on this line of rubber seat butterfly valves. First discussed are the design principles, followed by an explanation of the valve applications. Many photographs illustrate text. Remainder of the catalog contains engineering drawings and illustrations of the various type valves, including those handwheel, chainwheel, motor, cylinder and plain stem or lever operated. A section deals with special condenser circulating water valves, while another part of the booklet is devoted to the pulverized fuel valve and floor stands for manual or electric motor operation. Henry Pratt Co.

15 **Protecting Valves**—A line of bleeder line protecting valves is described in this 24-page Bulletin 8-K. Drawings and text describe the various valves and their operation. Cross section diagrams show integral parts of the different valves, specifying the part and giving the material of which it is made. A number of tables give complete dimensions, weights and connection sizes for each type valve. Schutte and Koerting Co.

16 **Steel Valves**—This handy pocket Bulletin 700, 24 pages, outlines the more widely used steel valves and gives catalog references where full details and dimensions of each valve may be found. Shown are stop, screw stop, gage, straight-through, non-return, blow-off, gate, check, hydraulic ball check and hydraulic stop valves and others. Noted are ASA working pressure ratings for each group of valves, and the uses to which these valves may be put. Edward Valve and Mfg. Co.

INSTRUMENTS, CONTROLS

17 **Insulation Tester**—Bulletin No. 21-45, 12 pages, contains information on the hand-operated type of insulation testers made by the company. It contains illustrations and descriptions of the instruments, together with details for selection purposes, applications, operating characteristics, prices and specifications. James G. Biddle Co.

18 **Air Filter Gauges**—Designed to cut down filter resistance is this line of air filter gauges described in Bulletin No. 187. Drawing and photographs show function of the gauges. Complete installation data is given. Gauges are shown to warn against accumulated dust and dirt, and show the proper time for cleaning or replacing filters. F. W. Dwyer Mfg. Co.

19 **Damper Control**—Complete engineering data is contained in this 4-page bulletin on damper control. The application and instructions for usage is discussed, as well as the specifications. A photograph helps point out the various features of the model DCR-A. Line drawings show typical installations. The cabinet dimensions are also diagrammed. Cleveland Fuel Equipment Co.

20 **Ammeter Tong Test**—This 5-page bulletin tells what the tong test ammeter does, what it features, what are its uses, what are its ranges, how accurate it is, what is its construction, and how it is used with high voltage circuits. There are ample photographs to illustrate these salient points. Typical scale ranges (actual size) are shown. These ranges are available for types that are illustrated. Columbia Electric Manufacturing Co.

PUMPS

21 **Pumping Units**—Bulletin 726-C is a 12-page catalog which describes the company's line of "Unipumps." Photographs of the pumps are presented and cross-sectional wash drawings show the construction and operation of the units. Two full page selection tables are included. Another full page of engineering information includes dimensional data on pump and motors; tables are supplemented by dimensional line drawings. An unusually useful section tells "How to Reduce Pump Costs." This is accompanied by full page

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MARCH, 1948

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friction table showing friction of water in pipes for various heads. Typical installations are pictured. Weinman Pump Mfg. Co.

22 **Chemical Feeders**—Contained in this handsome 16-page Bulletin CF-47 is information on a chemical feeder which is a positive displacement pump driven by a diaphragm motor which operates on gas or compressed air. Bulletin includes a description of the feeder, operating data, standard specifications and photographs of various models. Two beautiful color codes show operation of the diagrammed models. Black, Sivalls & Bryson, Inc.

23 **Turbine Pumps**—Bulletin No. 245, 6 pages, contains an enlarged specification drawing of these deep well turbine pumps. Noted in the drawing are the features of the discharge head, column, bowl assembly, suction pipe and strainer. American Well Works.

24 **Hydraulic Pumps**—This line of radial piston type hydraulic pumps is described in Bulletin 471, 6 pages. There is a brief comment on why the pump is dependable. A cut-away drawing shows its outstanding features. Two graphs show characteristic curves of the pumps (non-and reversible type) operating at full volume using oil with a viscosity of 900 to 1000 ssu at 100 F. Also included are four drawings and two dimensional tables, and photographs and descriptions of three radial pump controls. Hydro-Power, Inc.

25 **Turbo Pumps**—This booklet, 4 pages, describes the several lines of steam turbine centrifugal pumps and governor sets that this company produces. It lists their typical services, their ratings (boiler feed), their outstanding features, and the types manufactured, and includes cut-away half sections of pumps and governing gear. It also shows what data is needed for proposal. J. S. Coffin, Jr., Co.

PIPING, TUBING

26 **Boiler Tubes**—Complete engineering data is given in this excellent 36-page seamless boiler tube Bulletin No. 12. First discussed are general service considerations in operating boilers, followed by a description of the seamless boiler tubes. Method of making the tubes is described and illustrated with photographs of actual operations in company plant. A table and a graph indicate creep properties for several of the steels listed. An explanation is then given of the problem of control of boiler corrosion and incrustation. A table lists manufacturing weights in lb per ft of the tubes. The internal properties are then listed in a series of four tables covering the circumference, surface, area and volume. External properties are also tabled. Properties of saturated steam and super-saturated steam are listed in a group of tables. Attached to the bulletin is a folder discussing the bursting strength of boiler tubes. It includes many graphs and tables. National Tube Co., Div. United States Steel Corp.

27 **Power Plant Piping**—Bulletin No. 10, 60 pages, completely describes this line of power plant piping. Discussion in the beginning of the bulletin includes general information on the design, layout, and the selection of pipe for power purposes. The physical properties of this piping are then tabled and described, followed by a description of the specific uses in the power plant. Specifications for power piping, boiler tubes, heat exchanger and condenser tubes, etc., are given. Sixteen pages of photographs picture the manufacture of the pipes from mining of the ore to the finished product. Remainder of the booklet contains technical information on allowable working stresses; mathematical formulae, tables and discussion of expansion, elongation, cold spring, radii and tangents and deflection of pipe bends; graphs, tables, formulae for flow of steam, radiation and insulation, properties of saturated steam, and properties of superheated steam; and pipe tables, including weights and dimensions. National Tube Co., Div. United States Steel Corp.

28 **Pipe and Fittings**—A line of saran lined steel pipe and fittings is described in this 4-page bulletin. The line is completely diagrammed. Contained is a table of pipe sizes and dimensional drawings. A photograph shows the steel pipe cut back 3/16 in. from the face of the saran liner to provide gasket seal or joint. The steel pipe and fittings are thoroughly discussed in the text. Dow Chemical Co.

29 **Drain Pipe Data Book**—This 12-page drain pipe data book contains dimensional line drawings for each product, which are accompanied by tables of prices and dimensions. A list of typical installations is included along with descriptions of a pipe cutter and a number of kinds of rope packing. The Duriron Co., Inc.

PRIME MOVERS

30 **Combustion System-Diesels**—This 58-page handbook-size booklet gives a description of a combustion system for Diesels, and how it functions. Included is such elementary material as is necessary to give the reader an understanding of the subject. Points that are discussed are comparisons between types of fuels, differences between internal and external combustion engines, and gasoline and Diesel engines, as well as a full description of how a Diesel operates. Booklet is written in non-technical language and is well-illustrated with graphs, drawings and photographs. An appendix contains such tables as fractions and decimals of inches and millimeter equivalents, useful formulas, conversion factors and other tables. Lanova Corp.

31 **Diesel Generator Sets**—Bulletin 4709 is an 8-page illustrated catalog on Diesel generator sets, ranging in size from 175 to 1500 hp. The booklet describes and gives dimensions and specifications for the various models which include supercharged and non-supercharged six- or eight-cylinder sets. Ratings of generators are from 120 kw to 1055 kw. National Supply Co.

32 **High Speed Engine**—This high speed engine, for generating power as a by-product where steam is required, is described in 4-page bulletin. Two tables give full mechanical specifications and the ihp ratings at two speeds and with several steam pressures. Another table indicates the hp of high speed engines at ¼ in. cut off. Text contains information on the frame, cylinder, valve, piston, crosshead, connecting rod, crank shaft of side crank and of center crank, flywheel, side and center crank, governor, outboard bearing and lubrication. Erie City Iron Works.

33 **Steam Engine**—A balanced poppet valve steam engine is described in this 12-page bulletin. The principles that are used in operating the Lentz valve, valve gear, governor and hand speed adjustment is discussed. Various photographs and drawings illustrate the text. The selection of an isolated industrial or commercial power plant is also covered. Many photographs illustrate typical installations. Erie City Iron Works.

FANS, BLOWERS

34 **Fans**—Bulletin B-3804 is an 8-page booklet describing this line of fans suitable for high temperature applications—hot gases, corrosive fumes, explosive fumes, etc. A cross section of a fan shows special cone, designed to reduce losses in the elbow. It is indicated that the fans can be fitted with either an eight-bladed steel wheel or a three-bladed aluminum wheel, and that it also comes in straight-through type. Westinghouse Electric Corp.

35 **Soot Blowers**—Catalog No. 1014, 48 pages, gives complete information on the selection of soot blowers for efficient boiler operation. An excellently laid-out index shows how to locate specific type blower in the catalog. First discussed, together with illustrations, is a description of the operation of the automatic sequential air control system. This is followed by description of the various type blowers: automatic air puff soot, steam soot, short retracting soot, long retracting soot, telescopic retracting soot, and air heater blowers. Soot blower elements are then treated. Booklet concludes with description of line of water gauges and water columns, water alarm and smoke indicator. Diamond Power Specialty Co.

MATERIAL HANDLING

36 **Material Handling Equipment**—A complete line of this equipment is illustrated in handy 36-page Bulletin No. 801. Such items as chains, sprocket wheels, transmission machinery, feeders, conveyors, elevators, malleable castings, vibrating screens, magnetic separators, pulverizers, crushers, coal and ash handling systems, etc., are photographed. Jeffrey Mfg. Co.

37 **Electric Hoists**—Catalog H-46, 38 pages, contains complete engineering data on this line of stationary hoists, electric hoists and car pullers. Things to be considered when buying a hoist are discussed, followed by description of way to select proper hoist. Complete hoist data and types of controls available are listed in two tables. Two pages of drawings show fundamental types of grabs and methods of hanging I-beam track. Details of construction of the hoists are outlined and illustrated with a full page photograph. Remainder of excellent bulletin contains typical installation photographs and dimensional drawings and tables. American Engineering Co.

38 **Monorail Hoists**—These electric monorail hoists for either cranes or monorail systems are described in 6-page Bulletin S493S. Photographs show typical applications of the hoists. A chart lists various type hoists together with their capacity hoisting speed and height of lift. This information should help in deciding upon proper hoist needed in plant. American Engineering Co.

MAINTENANCE

39 **Gas Welding Rods**—This 24-page brochure is devoted exclusively to gas welding wire and its use. It covers complete line, giving application, procedure, proper torch adjustment, physical properties, etc., of each gas welding rod. Numerous application photographs are shown. Information is given on oxy-acetylene flames, torch tips, pipe welding, weights of weld metal deposit, weights of gas welding rods, estimate cost for manual oxy-acetylene welding. Back cover includes convenient reference chart of welding electrodes and gas welding rods. Page Steel & Wire Div., American Chain & Cable Co., Inc.

40 **Gas Cleaning**—An electrical precipitation method of cleaning gases is discussed and illustrated in this 24-page catalog. Ample photographs show typical installations. A series of drawings, together with text indicate how the electrical precipitation works. The two basic types of precipitators—pipe and plate—are described and illustrated with line drawings. A list of typical one-day collections, through use of the system is given. Research Corp.

41 **Tube Cleaners**—This line of tube cleaners for use in refineries, power plants and chemical process plants is described in 48-page Catalog No. 76. Almost all types of cutter-head are described, as well as brushes and air, steam and water driven motors. Electrically driven tube cleaning equipment and all accessories are described and illustrated. All descriptions of items include application data as well

(Continued on page 146)

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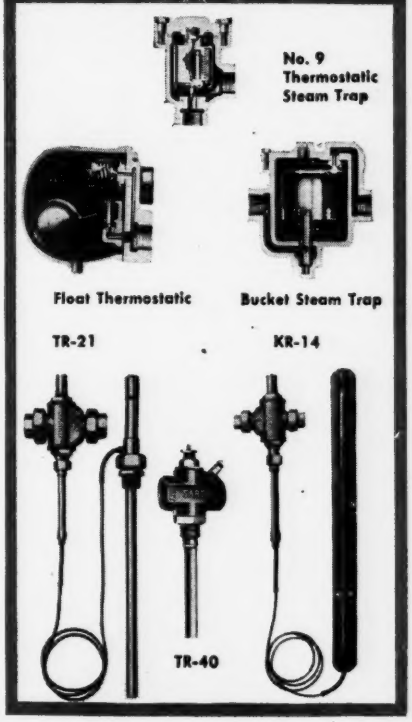

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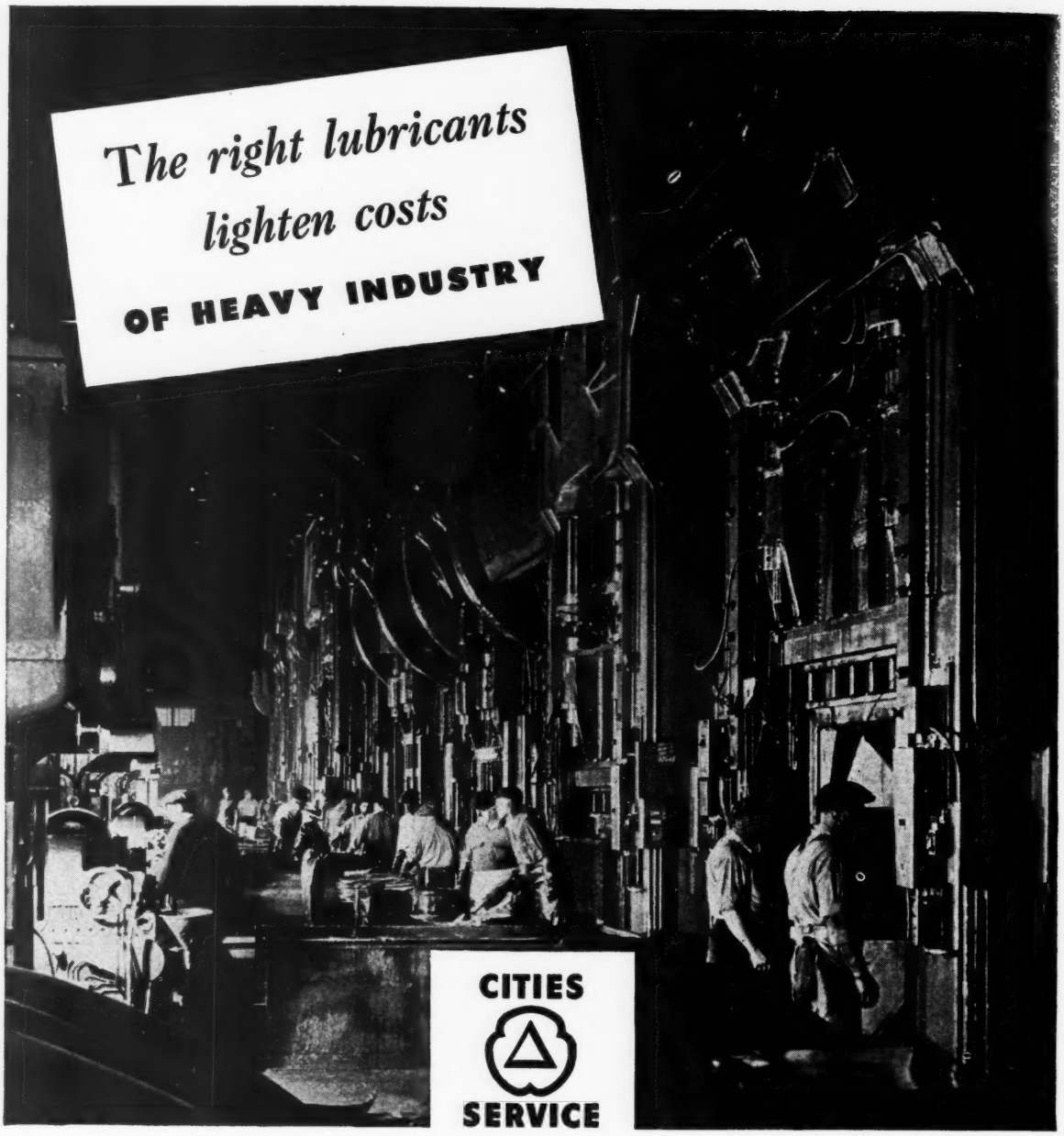

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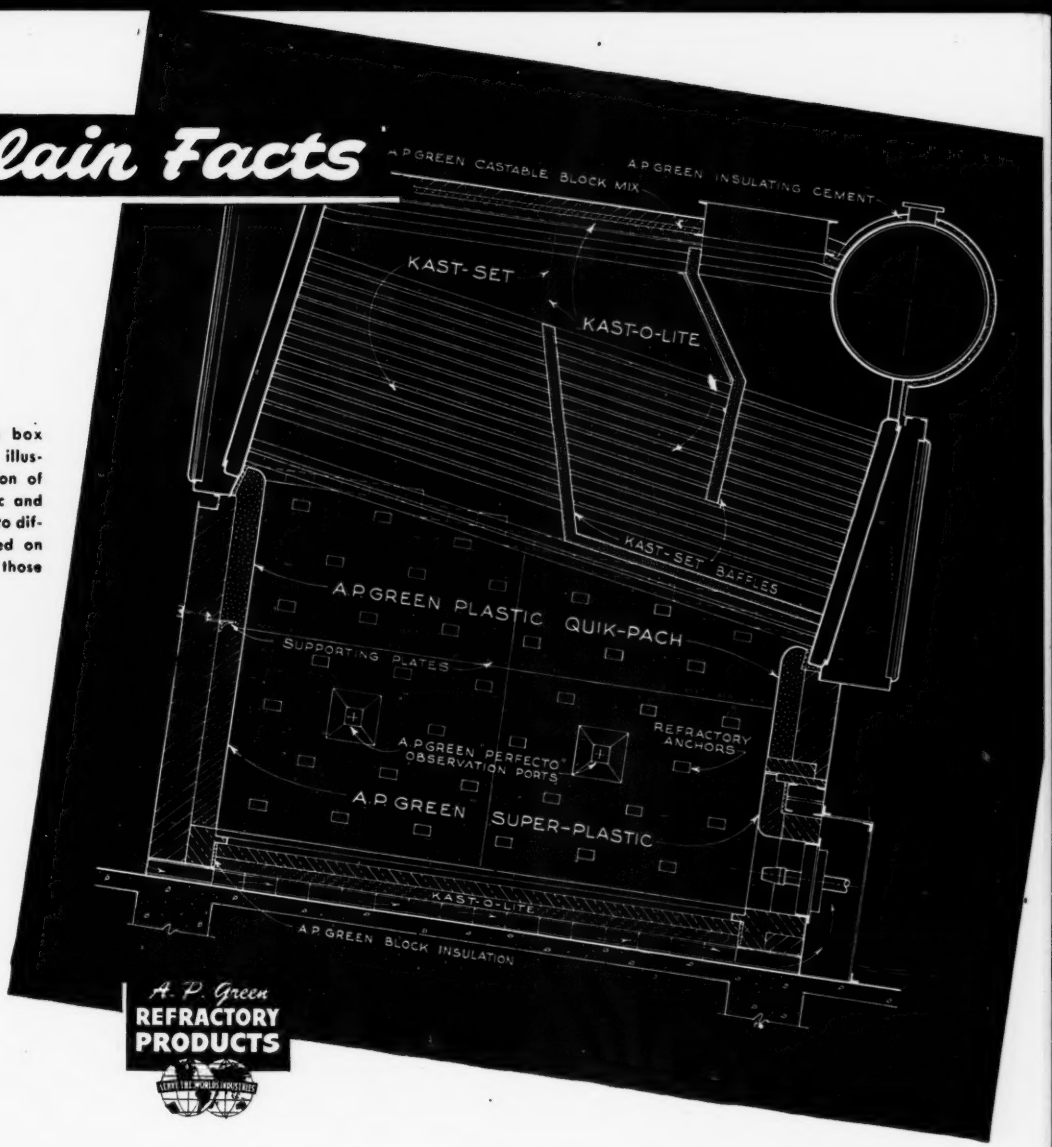

Typical cross-drum box header type boiler illustrating the application of A. P. Green's plastic and castable refractories to different sections, based on service conditions in those zones.

Advantages of A. P. Green plastic firebrick

Successful refractory installations must meet the varying service conditions in different sections of industrial heating and power units. It is both practical and economical to install a specific material to meet the condition in each section or zone. A. P. Green produces plastic and castable refractories "zone rated" to serve this purpose.

Complete monolithic linings can be installed quickly and easily. In monolithic construction, there are no exposed joints subject to attack by flame or slag—linings remain air-tight and do not bulge—longer service is obtained. Their ability to bear loads under heat and their lack of shrinkage under severe service conditions have proved the superiority of A. P. Green plastics.

SUPER-PLASTIC is well above the American Society for Testing Materials requirements for Super Duty Plastic Refractories (C176-44). It is recommended in zones where conditions are most severe.

PLASTIC Quik-Pach has long been a standard specification where high heat duty refractories are required.

Distributor warehouse stocks of A. P. Green's complete line of refractory materials are located near your plant. Call your A. P. Green distributor, or write us for further literature and complete details on the advantages of monolithic construction.

A. P. GREEN FIRE BRICK COMPANY

MEXICO, MISSOURI, U. S. A.

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NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

A Unit Heater. An all-electric suspension type unit heater, designed to give forced warm air circulation in less than a minute after the current is turned on, has recently been announced. These units are available in capacities ranging from 10 to 60 kw, with Btu outputs from 34,150 to 204,900. Voltages range from 230 to 460.

In a tiny office or a large factory, these heaters provide local or supplementary warmth when there is a need to save the cost of operating the main heating system. In sections where electric rates permit, the units can serve as a full-time heating system.

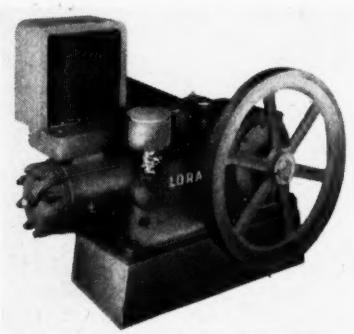
There are no exposed hot wires, coils or glowing elements. Therefore, the makers claim, no fire hazard, deterioration or oxidation is possible. Heat is furnished by a patented safety-grid, consisting of a nichrome resistor wire surrounded by insulating powder inside a seamless sheath which, in turn, is sealed in a one-piece finned casting of high thermal conductivity aluminum. Thermostatic control may be provided if desired. Electromode Corp.

B Floor Material. A new flooring material has been said to be stain, scar and flame resistant while possessing the resilient, yet longer wearing qualities of rubber floor covering. The material is a homogeneous mixture of vinyl resins, plasticizers, stabilizers, pigments and colors. Inorganic colors are used, with the exception of black, to give light age characteristics.

The material can be installed either in strip or tile form. Its thermoplastic quality permits it to flow around sharp corners and other indentations without cracking. An electrically controlled flooring heater, developed by the manufacturer of the flooring material, helps simplify installation procedures by heating the entire lap area to assure perfect seams. Chemical Products Div., Goodyear Tire & Rubber Co.

C Magnet Crane. A new one-man, single-engined, self-propelled magnet crane for handling iron and steel scrap and ferrous foundry products has been announced. The new crane has hydraulic steering, an 8 ft wheel base and a 22 ft turning radius. It accommodates 29 or 36 in. electromagnets powered by 3 kw or 5 kw generators. The machine is equipped with magnet tagline reel and has over-sized drums and clutches which are said to provide more precise control at all boom angles for piling, loading and unloading operations. The machine can be converted to a utility crane, clamshell or dragline, all attachments being used on the same 30 ft boom. By substituting a 15 ft boom, the machine can be used as a shovel or trench hoe. Wayne Crane Div., American Steel Dredge Co., Inc.

D Multi-Fuel Engine. This new single cylinder, horizontal, two cycle multi-fuel engine is rated at 34.3 hp at 450 rpm. It has a 9½ in. bore and 10 in. stroke with Timken bearings on crankshaft and cross-shaft. Wet-sleeve type cylinder liners are of alloy cast iron, assuring long life and easy replacement on location. The engine may be operated, full Diesel or converted to burn natural gas or butane as fuel. Conversion is easily accomplished in the field.



Condenser type cooling system eliminates need for water pump, and makeup water is negligible. Over-all dimensions are: height, 59 in.; length, 88 in.; width, 58 in. White-Roth Machine Corp.

E Flue Gas Analysis. As a means of checking on combustion efficiency in furnaces and boilers, this oxygen recording equipment has proved its ability to handle many applications which are beyond the scope of carbon dioxide recorders. In

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MARCH, 1948

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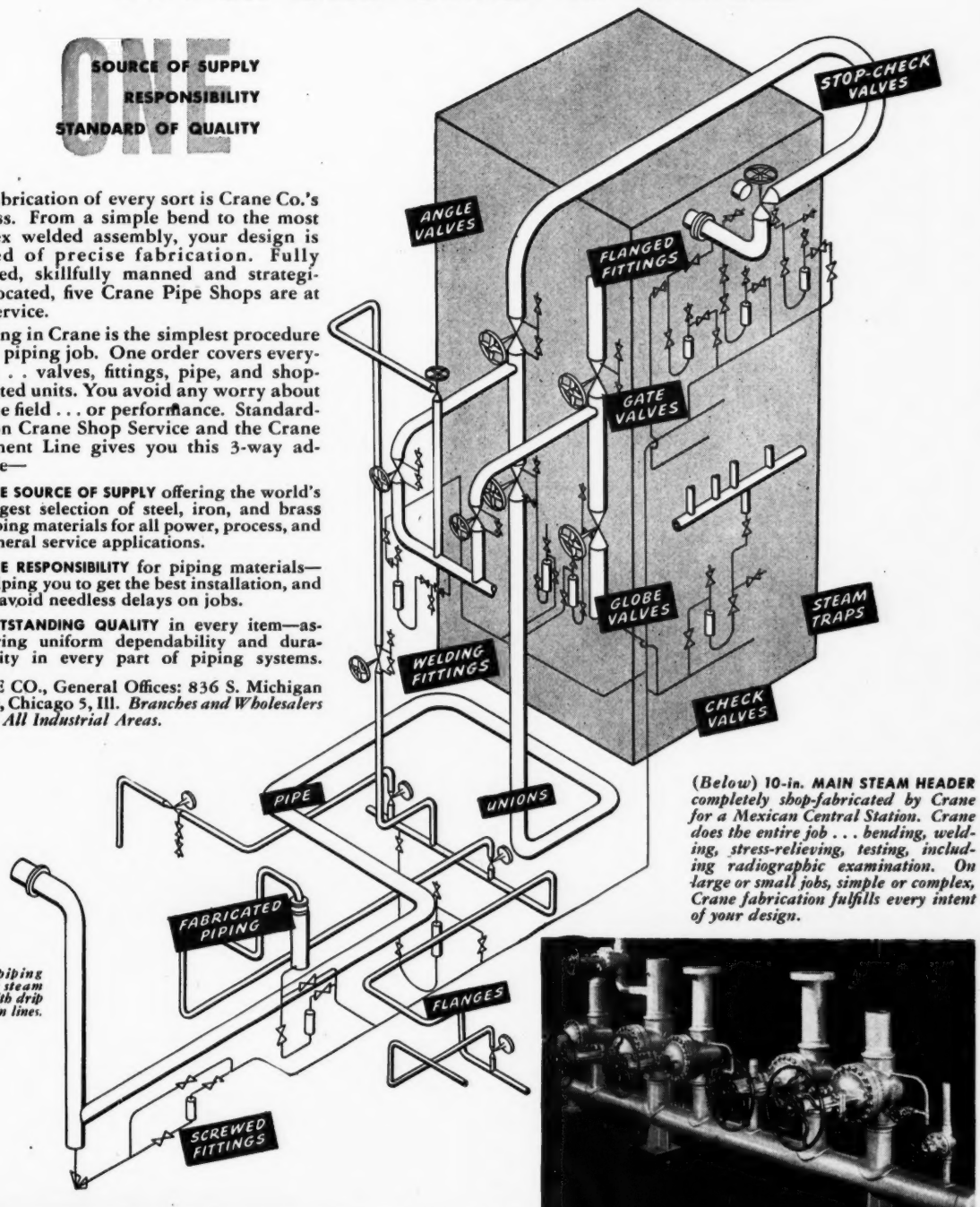
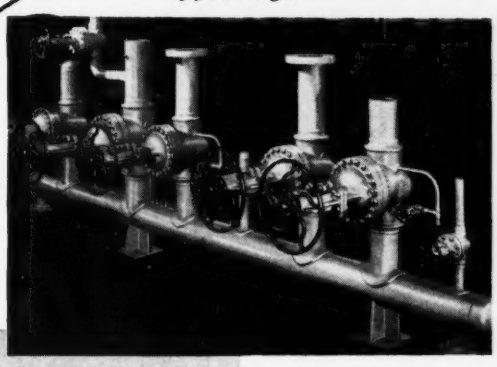


Boiler piping showing steam mains with drip and drain lines.

(*Below*) **10-in. MAIN STEAM HEADER** *completely shop-fabricated by Crane for a Mexican Central Station. Crane does the entire job . . . bending, welding, stress-relieving, testing, including radiographic examination. On large or small jobs, simple or complex, Crane fabrication fulfills every intent of your design.*



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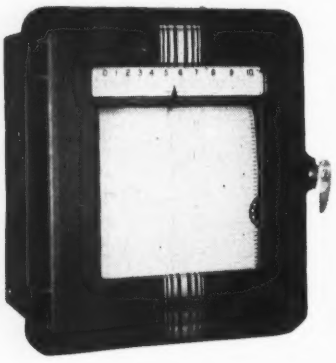
FOR EVERY PIPING SYSTEM

particular, this equipment is used as a guide to regulating excess air in furnaces such as glass tanks, cement kilns and open-hearth steel furnaces, where carbon dioxide is evolved by process reactions. It is also successful as a means of checking combustion in boiler furnaces which fire several different fuels simultaneously or in succession.

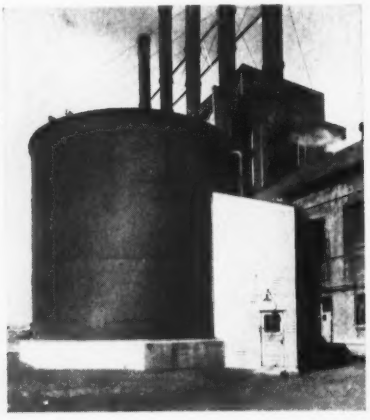


Analysis for oxygen is accomplished by the sensitive and accurate "hydrogen-difference" method, which consists of adding hydrogen to the gas sample, removing oxygen by combustion, and electrically comparing the conductivity of the sample before and after oxygen is removed.

Because all parts which contact gas are made of glass, the equipment is corrosion-proof and stable in calibration. The recording instrument can be either of two models . . . for extra visibility of scale, a round-chart Micromax; for a highly detailed record, a strip-chart model. Leeds & Northrup Co.

F Water Conditioning. Combining the basic elements of equipment for mixing, floc formation, settling, and thickening in a single reaction vessel, this rapid reactor is finding widespread application in industry for the conditioning of process cooling water and boiler feed. Chemical reagents may be introduced for coagulation of turbidity alone, for partial softening with coincident turbidity reduction, or for complete softening and turbidity reduction.

In the rapid reactor, raw water is introduced into an environment of chemical reagents and pre-formed precipitates, thoroughly agitated, discharged into a zone of relative quiescence at a controlled velocity, and finally passed into an integral settling and thickening reservoir from which it is collected for use.



By its improved design, the unit permits chemical reactions and separation of coagulated solids in only a fraction of the time necessary in intermittent cold process softeners. The retention time in a reactor will depend upon the characteristics of the raw water and the purpose for which the treated water is to be used, but usually is in the order of 60 to 70 min. Cochrane Corp.

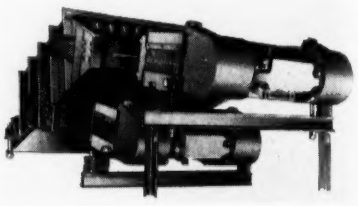
G Damper Control. A new electric remote damper control which provides, in one compact cabinet, all the elements for safe, automatic control of stack draft, has been announced. It is designed for protection to boiler plant equipment, reduction of smoke, soot and fly ash, and materially increased safety of boiler operation.

A differential adjustment may be set to any desired sensitivity by simply turning an easily accessible control knob. A selector switch gives complete manual control when desired, permitting full stack draft for soot blowing, inspection, etc., also full closed draft for boiler repairs, reduced load, etc. For normal operation, switch is set at "Automatic". An emergency cut-out switch makes it possible to instantly cut out all control and return to manual operation. An application plug adapts the control to stoker, oil or gas-fired boilers, permitting the same unit to be used with any fuel by inserting the proper plug. Three plug-in relays provide the time delay necessary for safe, efficient control.

This control is ideally suited for the needs of medium and small-size boilers such as are found in laundries, greenhouses, dairies, hotels, etc. Cleveland Fuel Equipment Co.

H Weatherproofing. A new coating material for weatherproofing outdoor metal surfaces has been specifically designed for maintenance of storage tanks, transformers, water towers and other steel structures. It is much thicker than paint and is said to make the metal surface to which applied impervious to measurable vapor and moisture transmission, acid and alkali gases and fumes, and other similar causes of deterioration. It can be applied by spray method. Packaged in 55 and 5 gal drums and pails, it comes in aluminum color. The Arco Co.

J Vibratory Grizzly Feeder. Specially designed for the large capacity separation of crusher feeds the double magnet, heavy duty electric vibratory grizzly feeder is available in different sizes and styles, either single or double magnet, with the magnets mounted above the deck or below, featuring the variable control of the rate of feed and with either full or partial grizzly decks.

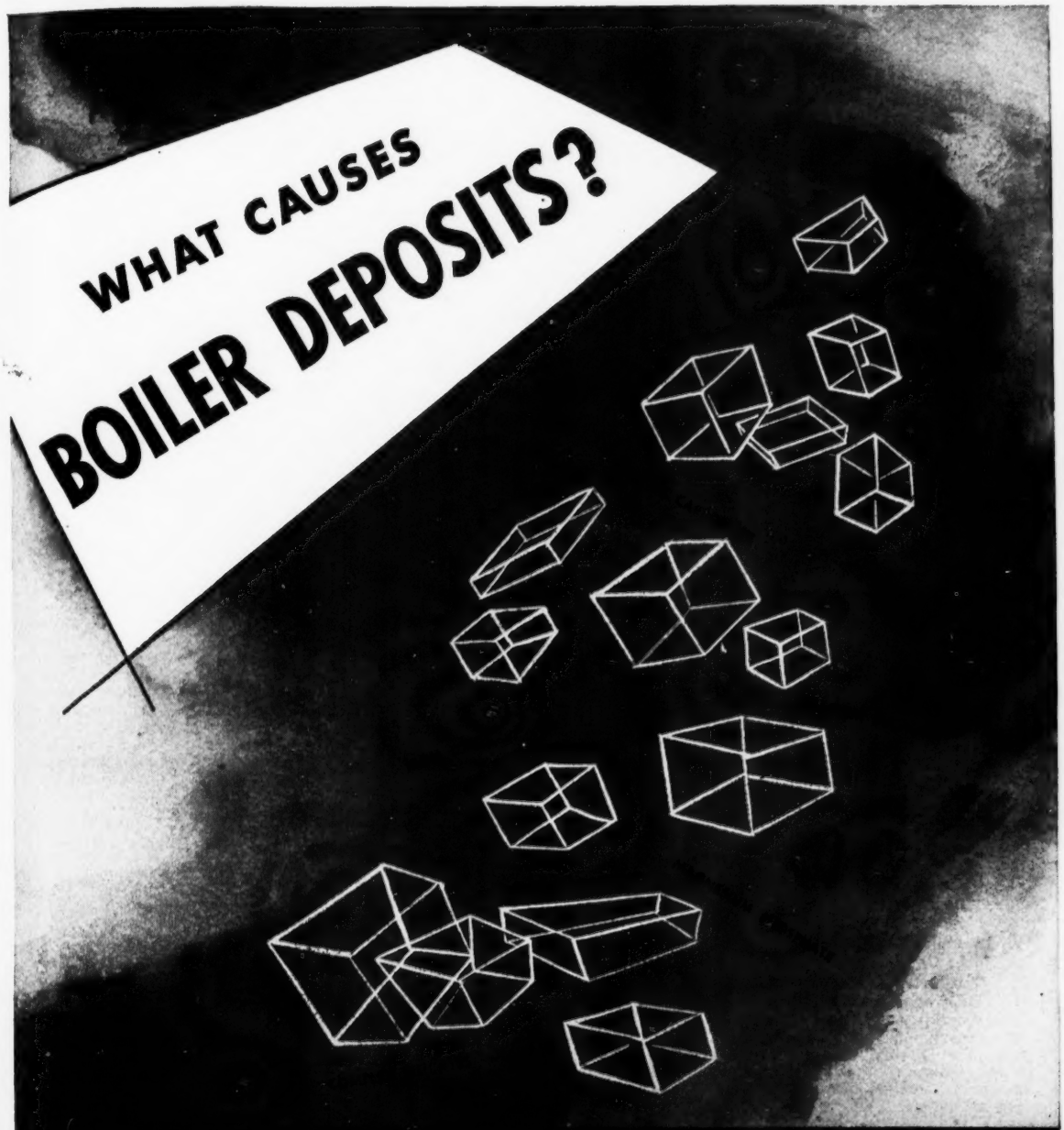


Operation is from 220 v, or 440 v ac. The small models can also be operated from 110 v, ac. Syntron Co.

K Suction Sump Pump. Designed to overcome one of the most common causes of pump failure—breaking of the pump shaft seal because of water pressure—a new sump pump has been announced.

The design embodies a new principle—"top suction." Because of this feature, the oil seal is subjected only to static pressure from depth of immersion when the pump is not in operation. When the pump operates, water cannot reach the oil seal on air motor.

The sump pump is operated by a powerful vane-type air motor. The pump impeller of the closed type is made of exceptionally hard, abrasion resistant alloy. A built-in oiler lubricates all moving parts of the pump with oil, the oil chamber having one-quart capacity for 24 hours' normal operation. This feature eliminates the grease fittings ordinarily used, which, when neglected, are frequent cause of bearing failure. Gardner-Denver Co.



Boiler deposits (scale and sludge) originate primarily from boiler make-up water, contaminated condensate returns, and corrosion of metal parts in the water system. Under the influence of heat and concentration, certain materials come out of solution and adhere to heat transfer surfaces as scale or sludge.

Drew Power Plant Chemicals and Services have been developed for the prevention of such deposits and for handling the other difficulties encountered in the use of industrial water.

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POWER DREW CHEMICALS

L Boring Tools. These solid carbide boring bars are designed for precision boring of holes having a length up to 8 times hole diameter. The bars are available in two types. The first type—using a carbide boring tool brazed into a recess in one end of the bar—is available in only one size. The second type—having a steel insert in which the carbide boring tool is held and adjusted with set screws—is standard in a range of 7 sizes. Carboloy Co.

M Portable Compressor. A new line of electric portable compressors in 60, 105, 160, 210, 315 cfm capacities has been announced. They are available in skid, 2-wheel trailer and 4-wheel trailer mountings. The compressors are of two stage construction with intercooler and safety valve. They are direct driven from 1200 rpm 220/440 v a-c motors of squirrel cage, horizontal type. Motor starters are full voltage, a-c magnetic non-reversing, standard sheet steel NEMA type 1, 3 phase, 60 cycle with heaters for motor protection. Davey Compressor Co.

N Ceramic Base Lining. This ceramic base lining can be used for tanks containing hot or cold water, for condensate receiving tanks, for water softening tanks, for brine and caustic tanks, and for many tanks used in the storage of acids. It has the quality of adhesion to steel and the same coefficient of expansion as iron and steel. It is said that it will expand and contract without checking or cracking under temperatures ranging from freezing to 230 deg.

The lining is manufactured in the form of a very fine white powder and is mixed with water to the consistency of mortar when applied. It is installed to a thickness of approximately one quarter of an inch by the use of special brushes. Elastic Porcelain Lining Corp.

O Smoke Indicator. A new electronic smoke indicator has been recently announced. It includes such features as an internally-wired panel box, density meter calibrated in Ringleman (0 to 5) and percentage smoke scales; alarm bell which can be mounted where desired; relays adjustable to energize alarms at any pre-determined density of smoke; green signal light to indicate operation of unit and red light to give visual warning of smoke violation; all adjustment controls in panel box; can be used with solenoid to operate steam jets and blower fans when smoky conditions occur in boiler, and a time delay relay can be provided to keep these on for one minute after smoke starts; units made for 115 v a-c or 115 v d-c. A recorder may also be used to record time and length of violation for permanent record. McNeill Engineering Co., manufacturers. Trimount Instrument Co., distributors.

P Packing. The self-lubricating feature of this packing is obtained through a novel alloy structure of anti-friction metals, which by a special process is impregnated with heat resisting, lasting lubricants

which cannot be driven off by working heat or pressure. Self-forming the packing molds itself to the size and shape of stuffing box, effecting a perfect seal, yet allowing rods or pistons to operate with minimum friction. Flexrock Co.

Q Flexible Couplings. These couplings are designed so that the only part that absorbs wear is the center member or block which has a free sliding action between the two jaw flanges of the coupling. This center member is faced with bearing strips which are the points of contact with the jaw flanges. The center block was recently improved so that the bearing strips now slide upon the center block to which they are secured. This greatly reduces the friction which results between the bearing strips and the flanges as the coupling rotates.

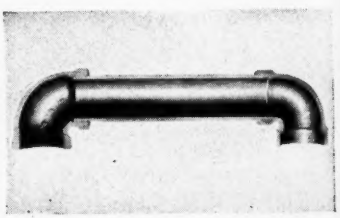
This coupling obtains its flexibility through design as compared with the conventional method of obtaining flexibility through the flexing of a resilient material. The purpose of the coupling is to permit shafts to operate misaligned with transmitting reactionary stresses which may increase the bearing temperature and accelerate the rate of bearing wear in the prime mover or driven machine. American Flexible Coupling Co.

R Protective Coating. This coating is said to form a black, tough, flexible, durable film, adheres firmly and has affinity to dry or wet, non-leaking surfaces. Two coats are applied and three in exceptional cases. It is composed of blends of specially treated high grade asphalts, plasticizing and adhesive compounds. It does not contain tar and is not an emulsion. The coating protects concrete, mortar, wood, clean and rusted steel, or other metal and non-metal surfaces, prevents penetration of water or dampness and seals pores and hairline cracks. Sika-Seal, the trade name, is applied to the inside of tanks, outside of buildings below grade, structural steel and other surfaces not exposed to heavy traffic or organic solvents. Sika Chemical Corp.

S Heating Coil. A broad range of types, models and sizes, plus major design improvements characterize this new line of heating coils. The new coils are available in standard steam, non-freeze, booster and hot water types, each in a wide variety of tube and fin combinations and casing sizes.

Absence of baffles or shielded headers within casings helps assure uniform, unrestricted airflow and low friction loss. Because all surface within casings is heat transfer surface, ducts no larger than the coil face area need be employed. Higher heating capacity per sq ft of coil face area is achieved through the use of scientifically die-formed fins. Coils are entirely of copper and copper-alloy throughout. Modine Mfg. Co.

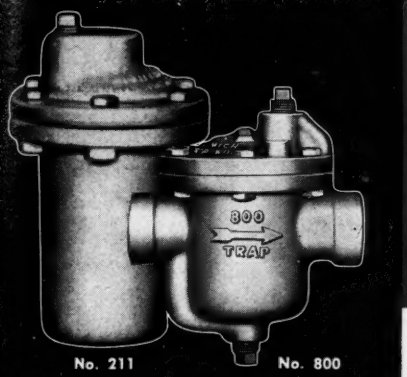
T Threadless Fitting. This threadless fitting is a black, malleable iron socket type fitting for brazing to steel or wrought iron. The cup of the fitting is reamed to accommodate the outside diameter of standard pipe and also to produce a shoulder or stop for the pipe when it is inserted. Close tolerances in the machining of the caps insure rigid support and a thorough bond. The



new fittings are made in sizes up to and including 2 in., and are applicable for 150 lb working steam pressure at 450 F, or 300 lb, non-shock, oil, water, or gas lines at 150 F. Stanley G. Flagg & Co., Inc.

U Remote Reading Gauge. These remote reading gauges permit instantaneous, automatic indication or recording without using any outside source of power. All gauges are float operated, eliminating the use of pumps, valves, etc., and errors due to specific gravity differences. Remote reading models utilize a temperature compensated, hydraulic transmission system. Accuracy is not impaired even though long lengths of transmission tubing are exposed to varying outdoor or indoor temperatures.

The gauges measure liquids of all kinds, whether light or heavy. Dial readings can be provided in feet and inches, gallons, pounds, liters or any other desired increment. Models are



No. 211 No. 800

Above left — Armstrong bottom inlet—top outlet series trap.

Above right — Armstrong No. 800 side inlet—side outlet trap.

PROOF THAT ARMSTRONG TRAPS PAY DIVIDENDS:

50% LESS heating-up time after changeover to Armstrong Traps.—*Preston's Pure Preserves, Ltd., Ville St. Laurent, Que.*

•

50% MAINTENANCE reduction and 20% FUEL savings with use of Armstrong Traps.—*Eastern Box Company, Baltimore, Md.*

•

MAINTENANCE REDUCED 50% by installing Armstrong Traps.—*Defender Photo Supply Co., Rochester, N. Y.*

•

HEATING-UP TIME REDUCED 20%, FUEL CONSUMPTION 10% and MAINTENANCE COSTS 75% when manufacturer of food stuffs unit trapped 20 steam jacketed kettles with Armstrongs.—*Griggs, Cooper Co., St. Paul, Minn.*

For Fuel Savings and Maximum Production

INSTALL STEAM TRAPS CORRECTLY!

IF STEAM traps are not installed correctly they may fail to do their job — and you lose money.

For fuel savings and maximum production, check your trap installations against the following:

1. **DO YOU HAVE A TRAP ON EACH UNIT?** When you drain more than one unit with a single trap, sluggish heating and low temperatures nearly always result.
2. **ARE YOUR TRAPS LOCATED CORRECTLY?** They should be placed close to and below the unit to provide better drainage and eliminate steam binding.
3. **DO YOU NEED STRAINERS?** If there is sufficient dirt or scale in your lines to interfere with trap operation, Armstrong Y-type strainers should be installed ahead of the traps.
4. **DO YOU HAVE A BYPASS ON CRITICAL UNITS?** Traps should be installed with a bypass. The ARMSTRONG STEAM TRAP BOOK shows the correct methods of installing traps and bypasses. Send for a free copy.

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ARMSTRONG *Inverted Bucket* STEAM TRAPS

No. 4 of a series of advertisements devoted to improving efficiency through better trapping.

available to automatically control pumps, motors, signals or other devices for maintaining minimum or maximum liquid levels. The Liquidometer Corp.

V Variable Speed Changer. This new variable speed changer is rated 20 hp for speed variation ratios of 5 to 1 and 6 to 1 and 25 hp for speed change ratios of 2 to 1, 3 to 1 and 4 to 1. It is made only in a plain basic type No. 1 horizontal assembly, with housing split horizontally. Thus, the housing consists of a top and bottom half. The unit is a compact, all-metal, fully enclosed and self-lubricating model. Link-Belt Co.

W Bench Grinder. This ball-bearing utility bench-grinder was designed for general purpose grinding within rated capacity. It is suitable for small shops and for general industrial use. The motor is ⅓ hp capacitor type, ball-bearing, totally enclosed, 3450 rpm load speed.

The grinder is equipped with 1 coarse and 1 fine abrasive wheel, 6 x ¾ x ½ in.; tool rests adjustable to wheel wear; 7 ft 3-conductor rubber covered cable, with one wire for grounding and attachment plug and with rubber feet and provisions for bolting to floor. It weighs 40 lb and can be furnished for 110 or 220 v, 50 or 60 cycle, 1, 2 or 3 phase a-c. The United States Electrical Tool Co.

X Corrosion Resistant Pipe. Announcement of the development of a new type of corrosion resistant pipe and fittings has been made. The product, Saran-lined steel pipe designed to convey corrosive liquids, combines the desirable features of steel pipe—rigidity and pressure strength—with Saran's extreme resistance to chemicals.

Saran-lined steel pipe is resistant to a very wide range of chemicals, oils and solvents. It will satisfactorily carry corrosive sulphuric, hydrochloric, nitric and phosphoric acids. The working temperature of the pipe, important to chemical engineers, ranges from 0 to 190 F, depending upon service conditions. Dow Chemical Co.

Y Puller. This new puller is a portable, lightweight compact device operated by a ratchet handle. Aluminum alloy castings have considerably reduced the weight with no sacrifice of strength. It is used for pulling any object in a horizontal or vertical direction or at any possible angle. If necessary the unit can be used in an upside down position. An automatic friction type load brake holds the load securely at any point. It can be used for tightening guy wires, stretching fence, opening railroad car doors, setting pipes, meters, pulling trolley wires and cables, etc. Chisholm-Moore Corp.

Z Air Diffuser. These new air terminals have the distinct advantage of adjustability. The air supply can be directed at any angle from vertical to horizontal and its volume regulated in each diffuser. This air direction feature provides a safeguard against drafts and is a simple meaus of deflecting the incoming air away from or into a particular area, process or machine. The air-volume control, a cylindrical, sleeve-type damper within the neck of the diffuser, permits rapid balancing of the system as well as increasing or decreasing at will the air supply at individual points or zones.

Installation economy is another feature of these diffusers. The inner assembly of the diffuser (lower cone and damper) is removed and replaced as a unit. This is especially advantageous where ceilings already exist, as by simply removing the inner assembly the outer cone is attached to duct or collar quickly and easily. W. B. Connor Engineering Corp.

AA Conveyor-Elevator. A new continuous conveyor-elevator, suitable for handling bulk foods, dry chemicals, coal or any granular, flaky, pulverized or small lump materials, has been announced. The material is conveyed and elevated in any direction, in a solid mass, entirely enclosed within the belt. At discharge point, the belt is automatically opened for complete discharge and the belt is opened to permit cleaning the last vestiges of material from the belt. Stephens-Adamson Mfg. Co.

BB Steel Mat Flooring. With the same steel qualities of resistance to shock and wear, this steel mat flooring is designed to protect the floors of industrial plants of all sizes from the severe wear of heavy traffic, dumping of loads, weight of machines, storage, etc. The flooring is hexagonal shaped steel grid which is easily imbedded in concrete or mastic, over old or new floors, and when so imbedded makes a solid, level floor. The exposed steel top of the mesh, flush with the surface, takes the shocks and carries the brunt of the loads. Klemp Co.

CC Wound-Rotor Motor. A line of improved totally-enclosed, fan-cooled, wound-rotor motors has been announced. The motors are built with an improved tube-type air-to-air heat exchanger, first used for squirrel cage motors. The greater efficiency of this exchanger permits a reduction in size compared to older, totally-enclosed, fan-cooled designs. The improved motors are suitable for all fields of industry, since they can be readily adapted to suit the requirements of any special industry.

To assure trouble-free operation under extremely unfavorable atmospheric conditions, the motors can be built with stainless steel ventilating tubes, fans, and end plates and cast iron terminal boxes and collector ring enclosures. Allis Chalmers Mfg. Co.

DD Gate Valve. A new 200 lb bronze gate valve, incorporating a new application of full cylindrical body sections, has been recently announced. These valves are designed to provide maximum resistance against distortion of the valve body and seats due to pipe line stresses and internal pressure strains. Exhaustive tests are said to demonstrate that this design will not distort and will maintain initial proportions and seat tightness. These valves are made in sizes ¼ to 3 in.

Among the features are a patented silicon alloy stem material which helps eliminate stem-thread failures; hexagon head gland; beveled disc wing guides and body guides channels to make assembly easy when servicing the valve. The Lunkenheimer Co.

EE Extruded Fittings. A new line of extruded fittings, fabricated from standard tubing of corrosion-resistant alloys, has been recently announced. The fittings are made in twelve sizes from ¼ to 4 in. in diameter, and in eleven shapes from tee to full return bend. They are made in Monel, Inconel, Nickel and stainless steels 316, 347 and 304. As they are able to handle gases and liquids with varying degrees of temperatures and corrosive agents, the fittings are particularly useful in chemical, food processing, pulp and paper industries.

An outstanding feature of the line is the lock flange, which affords a simple, economical method of installing demountable alloy piping. Just a few twists with a set screw wrench breaks the lock flange joint. The simple, direct connection is just as easily restored. All fittings are designed for tubing of the same diameter and wall thickness as the fittings. Northern Indiana Brass Co.

FF Steam Generator. This new dual-fired steam generator is an automatic package type steam generator. It has a full length refractory lined fire box that consumes all the fuel before it reaches the tubes and produces an incandescent firing chamber. As a result, it is said that the tube life is lengthened because flame does not touch the tubes and fuel is burned more completely and efficiently. It is shipped completely bricked and insulated ready to set down and fire. It is available for use with all three major non-solid fuels, light oil, heavy oil or gas, and for firing solid fuel either by hand or stoker.

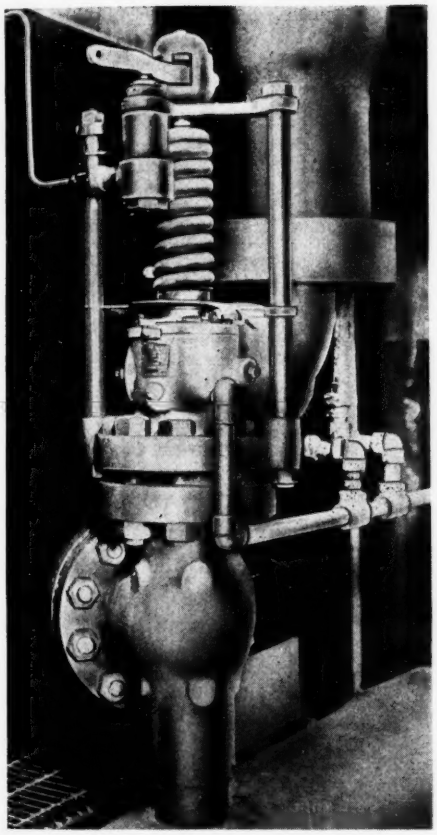
The manufacturer points out that this convertible boiler not only offers a method of alleviating present shortages but also provides protection against the lack of availability or prohibitively high price of any fuel in the future. This means that a whole new steam plant need not be bought should one particular fuel become unavailable or too high priced. C. H. Dutton Co.

GG Connectors and Couplings. A new line of pressed steel connectors and couplings specifically designed for use with electrical metallic tubing has been announced. The new products, having electro-galvanized finish, are said to be easy to inspect and particularly advantageous for use in close quarters and corner installations.

The coupling slips easily over the thin wall tubing ends in a close accu-

Give Your Boilers a Break!

End Safety Valve Troubles by Installing FOSTER 38-SV Safety Valves with these 5 GUARANTEED ADVANTAGES:



Hundreds of Foster 38-SV Safety Valves are giving top performance in important installations. This 2½" superheater unloading valve operates at 1450 lb., 950° total temp. Others are in service up to 2575 lb. at 1000° F.

1 Built to Stay on the Job—the Foster 38-SV is the SAFETY valve that is built to pop without causing boiler outages. On accelerated tests in an Eastern Utility, one of these valves has been popped every day for more than 6 years. It has had only routine maintenance, and yet it pops consistently at set pressure, and does not leak. In the Chief Engineer's own words—this is the equivalent of at least 40 years' normal service.

2 Accurate Popping—Once set at the desired popping point, the Foster 38-SV pops on the button for each successive pop. For instance, in another Utility installation, the 38-SV under test was set for 600 lb. and popped 50 times in quick succession. The first pop was at 600 lb. and the 50th pop was at 595 lb. In spite of the heat of this abnormal operation, the Foster 38-SV was thrown off less than 1%. After a short cooling period, it again popped at 600 lb. That's test gauge accuracy!

3 Minimum Blow-down—Foster 38-SV's are adjustable so they can be set to reseat when pressure has dropped as little as 1% below the popping point. In this same test the 38-SV, on its first pop, reseated at 594 lb. for a 6 lb. or 1% blow-down. On the 50th pop, it reseated at 589 lb. which is also 6 lb. or 1%. After each pop, it reseated positively with no chattering or leakage. Only over-pressure up the stack—no useful steam wasted.

4 High Relief Capacity—Foster 38-SV's have larger bore because they can handle larger volume of steam and still control blow-down. Depending on operating conditions, they may give more than twice the capacity of other makes, as in the case of 5 Foster 38-SV's required to replace 12 "conventional" safety valves of the same nominal size. Fewer valves to buy—fewer valves to service.

5 Low Maintenance—Hot or cold, the piston in the 38-SV fits loosely and cannot stick, and yet no steam reaches the spring. The spring stays cool enough to touch, even while the valve is popping—which means longer spring life. Disc and seat expand at the same rate during heating-cooling cycles—there is no drag to destroy seating surfaces. Simmering and chattering have been eliminated as a source of destruction. Discs will not warp or crack. When routine inspection and maintenance are indicated, complete loading assembly lifts out without disturbing the spring setting.

For full details on the design and construction features that enable this valve to outperform any other safety valve, get in touch with your Foster Representative or with us direct.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

111 MONROE STREET • NEWARK, N. J.

rate fit. Positioning of the conduit is controlled by a small integral stop. Gripping is secured by the action of an embedding screw working through a boss. When the screw head is driven down to rest on the boss, the tip of the screw becomes embedded in the tubing wall. A safe holding action is thus secured. National Electric Products Corp.

HH Unit Heater. This unit heater features a unique motor-cooling method known as "open-stack" ventilation. By mounting the motor in a stack, which is open at both ends, at the center of the circular heating core, company claims to have eliminated "motor-baking," a puzzling problem heretofore common to vertical discharge type units.

Specially designed fans draw room air through the open ventilating stack, while at the same time directing the air taken from the heated core downward through the fan opening. This provides a flow of air around the motor which reduces the motor operating temperature as much as 75 deg. The seven models in the line were designed to deliver from 52,600 to 552,000 Btu's per hr under standard operating conditions. Young Radiator Co.

JJ Wire Rope Slings. These flat-laced wire rope slings consist of a flat body made with six parts of wire rope laced together in a manner that eliminates placing the parts in shear under the pressure of a load. This construction of the body section produces a flat and flexible support twice as wide as its thickness. Because of its flat, belt-like surface, load pressure is distributed over a greater area than with a round bodied sling, resulting in less wear to the sling and less marking of highly finished surfaces on the load. A. Leschen & Sons Rope Co.

KK Flow Control Valve. A new flow control valve for air or hydraulic cylinder speed control, which provides more accurate control of cylinder speed plus the important new feature of unrestricted flow from the cylinder, has been announced.

The new valve, it is claimed, assures full use of air or hydraulic cylinder power because it eliminates abnormal pressure of the exhaust from the return side of the cylinder, increasing the cylinder effective power pressure. When the flow is to the cylinder (in either direction), the ball check instantly closes and the flow path is directed through the flow control valve, which has a wide range of adjustment. The reverse flow from the cylinder is unrestricted because the unloaded ball check opens wide on a slight change in pressure.

Another important feature of the new flow control valve is its compact size—only slightly larger than the pipe size. The valve is made in ¼, ⅜ and ½ in. pipe sizes from brass hexagon roll bar stock, all other parts being stainless steel. Pneu-Trol Devices, Inc.

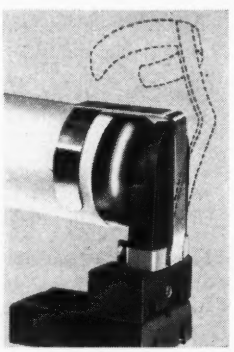
LL Starting Switch. A new manually operated snap switch for starting motors of one hp or less has been announced. It is a streamlined unit with molded plastic cover, and has an overload device which operates on the soldered ratchet principle. It is impossible to hold the switch closed under sustained overload, but can be reset easily, with the regular switch lever, after the overload is cleared.

The switch unit can be furnished without enclosure for mounting in a standard switch box or machine base. Various types of enclosures are also available to meet any industrial requirement. Allen-Bradley Co.

MM Masonry Saws. Among the improvements incorporated in the new design of these masonry saws for cutting brick, tile, concrete, quarry tile, fire brick, for industrial plants and furnace maintenance, are the dual belt drive, snap-on blade cover, positions for instant one-man change and fully adjustable conveyor clamps, both elevating and non-elevating types. The use of the "multiple cutting action" minimizes the arc of contact and exhausts cut-away particles as soon as they are cut. This allows the blade to cut its own path. Clipper Mfg. Co.

Stainless Steel Clip

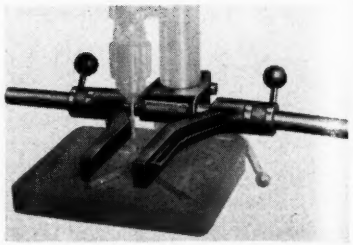
NN This safety clip holds fluorescent tubes in place regardless of the amount of vibration to which they are subjected. Made of resilient stainless steel, the clips are per-



manently installed by simply tightening nut on a precision-made machine screw. The band that holds the tube is easily pulled aside when lamps are replaced, and resumes holding position when released. Two safety clips are required for each tube. They are made in two sizes—for 40 and 100 w tubes—and their cost is low, 30 cents and 35 cents a pair, respectively. General Scientific Equipment Co.

Safety Work-Holder

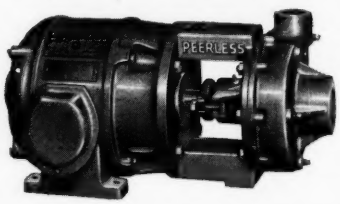
OO This new work-holder quickly clamps to the column of any small standard drill press, and instantly secures the work with only a quarter-turn of a single lever. In many cases, this new tool can substitute for simple drill jigs, thus simplifying tooling and cutting costs. By replacing makeshift devices such as bolts and C-clamps, it enhances safety and increases accuracy. The clamping arms are instantly



adjustable along the length of the cross arm to encompass the full width of the drill press table and are quickly swung back to clear a drill jig or machine vise when necessary. Standard sizes fit drill presses with columns of 1⅝, 2¼, 2¾, 3, 3½, 3¾ or 4 in. diameters. Universal Vise & Tool Co.

Centrifugal Pump

PP A general utility centrifugal pump, with power drives from fractional to 20 hp, has been recently introduced. It is a single stage, end suction and vertically split case centrifugal pump, and is being manufactured in two types, both of which are capable of moving water and other liquids in capacities up to 1000 gpm against heads up to 270 ft. Type PE is an integrally coupled,



compact electric unit in which pump and driving motor are anchored on the motor footing. Type PB is a belt driven unit with the iron frame and bearing mounts supporting the various pump sizes integrally cast. The latter type pump is either keyed to a V or flat belt pulley, as desired, or directly connected to a standard horizontal electric motor by means of a pin type flexible coupling. Peerless Pump Div., Food Machinery Corp.

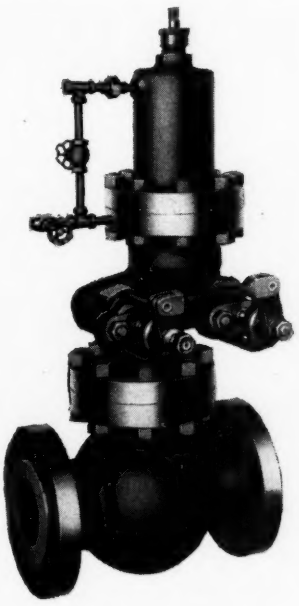
Packing

QQ The self-lubricating feature of this packing is obtained through a novel alloy structure of anti-friction metals, which by a special process is impregnated with heat resisting, lasting lubricants which cannot be driven off by working heat or pressure. Self-forming the packing molds itself to the size and shape of stuffing box, effecting a perfect seal, yet allowing rods or pistons to operate with minimum friction. Flexrock Co.

Insulator

RR Alfol asbestos is a new lightweight insulation consisting of a layer of aluminum foil laminated to ½ in. thick corrugated asbestos reflects 95 per cent of radiant heat, is completely fire-resistant, requires small storage space, is easy to cut, fit and apply. Comes in 250 sq ft rolls 36 in. wide. Recommended for high temperature applications, as boilers, ovens, radiator enclosures, pipe and duct insulation, etc. Reflecto Corp.

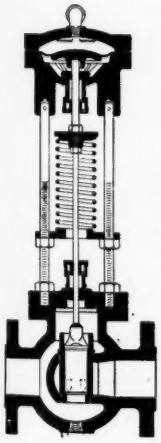
COPES BOILER-FEED PUMP CONTROLS



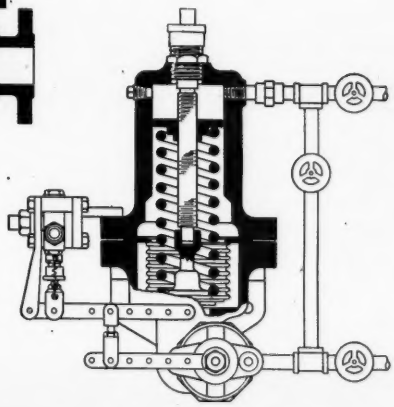
Constant-speed centrifugal boiler-feed pumps need no pressure control when the feed water regulator is a COPES Flowmatic, but in all other cases good feed regulation begins at the feed pump. With a single boiler fed by a single steam-driven pump, a COPES Feed Water Regulator can be used to vary the pump speed according to boiler water level changes. With two or more boilers fed from a common water supply, the desired constant excess pressure can be provided by a COPES Pump Governor in either steam supply or discharge line. In high-duty service, a comprehensive Master Control system can be provided. In any case, the control is designed and built for accuracy, dependability and long service life under the specified conditions. Write for data.

ENGINEERED BY THE MAKERS OF COPES

FLOWMATIC



Type SLDG
Governor for small steam-driven pumps



MASTER CONTROL
for two or more pumps maintaining a common pressure

NORTHERN EQUIPMENT COMPANY
382 GROVE DRIVE, ERIE, PA.
BRANCH PLANTS: Canada, England, France, Austria
Representatives Everywhere

COPES

Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

★ Tops FOR TOP PRESSURES

On steam lines where pressures go as high as 1500 psi, and temperatures up to 900° F. are encountered, steam traps must be rugged . . . and *efficient!*

That's why so many public utilities and other high pressure steam plants are installing Yarway Integral Strainer Impulse Steam Traps. First cousin to the famous standard Yarway Impulse Steam Trap, the integral strainer trap has been developed especially to meet high pressure trapping requirements.

It has ample condensate capacity when system is being "warmed up." Yet it will handle relatively small amounts of condensate efficiently without losing prime. The valve closes positively in the presence of dry or superheated steam.

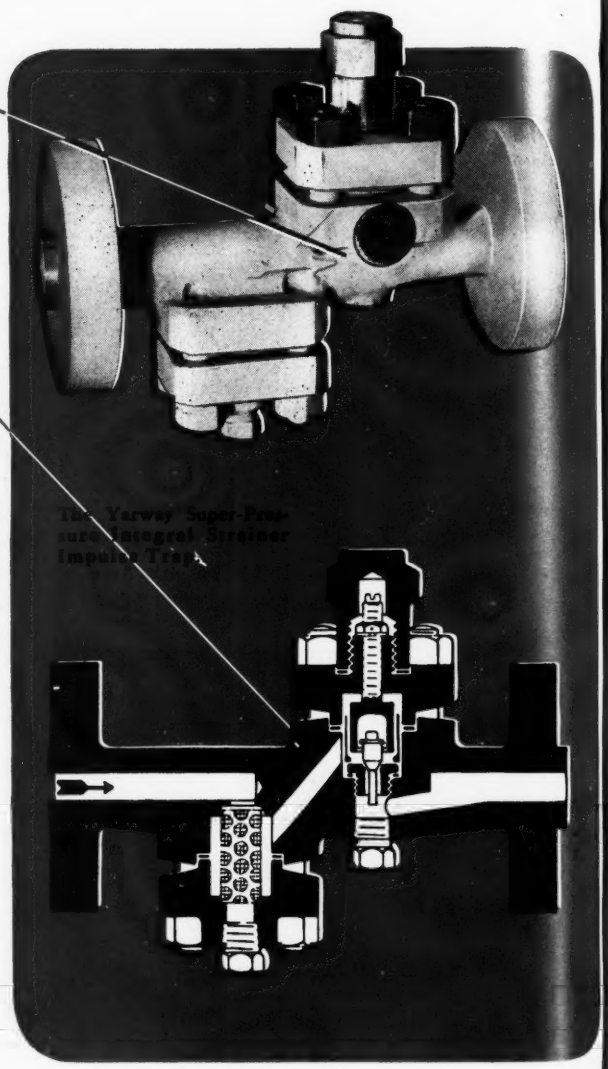
It is a fraction of the size and weight of other type traps designed for the same service—saving space simplifying installation and requiring no supports.

It is suitable for all pressures within a wide range without change of valve or seat.

It has the same simplicity of design as does the standard Impulse Trap shown below—only one moving part, the same little valve.

Its integral strainer protects trap against scale and rust in the piping system.

Available with flanged or socket weld connections. Write for Bulletin T-1739.



The Yarway Super-Pressure Integral Strainer Impulse Trap.

The Standard Yarway Impulse Steam Trap. Note only one moving part — a little valve.

See these traps and other Yarway steam plant equipment . . . hear their operation described by Lowell Thomas in the Yarway color motion picture, "There Is An Engineering Reason." Available without charge for group showings. Write today.

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Canons of Ethics for Engineers

BY THE ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT

HONESTY, justice and courtesy form a moral philosophy, which associated with mutual interest between men, constitutes the foundation of ethics. The engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life. It is his duty to practice his profession according to these Canons of Ethics.

As the keystone of professional conduct is integrity, the engineer will discharge his duties with fidelity to the public, his employers and clients, and with fairness and impartiality to all. It is his duty to interest himself in public welfare, and to be ready to apply his special knowledge for the benefit of mankind. He should uphold the honor and dignity of his profession and also avoid association with any enterprise of questionable character. In his dealings with fellow engineers he should be fair and tolerant.

Professional Life

Sec. 1. The engineer will cooperate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools and the scientific and engineering press.

Sec. 2. He will not advertise his work or merit in a self-laudatory manner, and he will avoid all conduct or practice likely to discredit or do injury to the dignity and honor of his profession.

Relations With the Public

Sec. 3. The engineer will endeavor to extend public knowledge of engineering, and will discourage the spreading of untrue, unfair, and exaggerated statements regarding engineering.

Sec. 4. He will have due regard for the safety of life and health of the public and employees who may be affected by the work for which he is responsible.

Sec. 5. He will express an opinion only when it is founded on adequate knowledge and honest conviction while he is serving as a witness before a court, commission or other tribunal.

Sec. 6. He will not issue ex parte statements, criticisms or arguments on matters connected with public policy which are inspired or paid for by private interests, unless he indicates on whose behalf he is making the statement.

Sec. 7. He will refrain from expressing publicly an opinion on an engineering subject unless he is informed as to the facts relating thereto.

Relations With Clients and Employers

Sec. 8. The engineer will act in professional matters for each client or employer as a faithful agent or trustee.

Sec. 9. He will act with fairness and justice between his client or employer and the contractor when dealing with contracts.

Sec. 10. He will make his status clear to his client or employer before undertaking an engagement if he may be called upon to decide on the use of inventions, apparatus, or any other thing in which he may have a financial interest.

Sec. 11. He will guard against conditions that are dangerous or threatening to life, limb or property on work for which he is responsible, or, if he is not responsible, will promptly call such conditions to the attention of those who are responsible.

Sec. 12. He will present clearly the consequences to be expected from deviations proposed if his engineering judgment is overruled by non-technical authority in cases where he is responsible for the technical adequacy of engineering work.

Sec. 13. He will engage, or advise his client or employer to engage, and he will cooperate with, other experts and specialists whenever the client's or employer's interests are best served by such service.

Sec. 14. He will disclose no information concerning the business affairs or technical processes of clients or employers without their consent.

Sec. 15. He will not accept compensation, financial or otherwise, from more than one interested party for the same service, or for services pertaining to the same work, without the consent of all interested parties.

Sec. 16. He will not accept commissions or allowances, directly or indirectly from contractors or other parties dealing with his client or employer in connection with work for which he is responsible.

Sec. 17. He will not be financially interested in the bids as or of a contractor on competitive work for which he is employed as an engineer unless he has the consent of his client or employer.

Sec. 18. He will promptly disclose to his client or employer any interest in a business which may compete with or affect the business of his client or employer. He will not allow an interest in any business to affect his decision regarding engineering work for which he is employed, or which he may be called upon to perform.

Relations With Engineers

Sec. 19. The engineer will endeavor to protect the engineering profession collectively and individually from misrepresentation and misunderstanding.

Sec. 20. He will take care that credit for engineering work is given to those to whom credit is properly due.

Sec. 21. He will uphold the principle of appropriate and adequate compensation for those engaged in engineering work, including those in subordinate capacities, as being in the public interest and maintaining the standards of the profession.

Sec. 22. He will endeavor to provide opportunity for the professional development and advancement of engineers in his employ.

Sec. 23. He will not directly or indirectly injure the professional reputation, prospects or practice of another engineer. However, if he considers that an engineer is guilty of unethical, illegal or unfair practice, he will present the information to the proper authority for action.

Sec. 24. He will exercise due restraint in criticizing another engineer's work in public, recognizing the fact that the engineering societies and the engineering press provide the proper forum for technical discussions and criticism.

Sec. 25. He will not try to supplant another engineer in a particular employment after becoming aware that definite steps have been taken toward the other's employment.

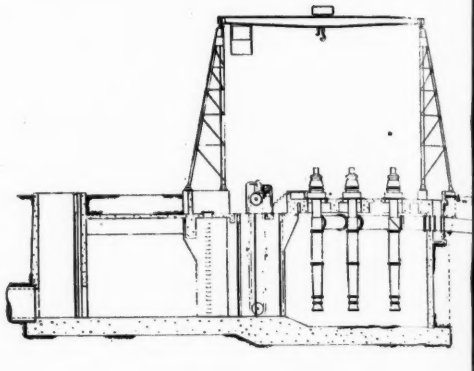
Sec. 26. He will not compete with another engineer on the basis of charges for work by underbidding, through reducing his normal fees after having been informed of the charges named by the other.

Sec. 27. He will not use the advantages of a salaried position to compete unfairly with another engineer.

Sec. 28. He will not become associated in responsibility for work with engineers who do not conform to ethical practices.

Harbor Steam Plant Nears Completion

To meet rapid and continued post-war load increases, Los Angeles is carrying out planned construction program at Harbor Steam Plant to have ultimate capacity of 363,000 kw . . . Unit No. 1, a 65,000-kw installation, was described here in 1943; Unit No. 2, in operation November, 1947, was a duplicate . . . To complete station, Units Nos. 3, 4 and 5 now being added . . . "Unit" design—one boiler per turbine . . . Why 1800-rpm units were chosen . . . No. 1 and 2 units for quick pick-up; last three for block load, each with capacity of 75,000 kw . . . Firing with oil and gas, perhaps future pulverized coal . . . Twin condensers as in original installation . . . Details of controls, auxiliaries and drives, and electrical connections . . . Auxiliary power from generator bus . . . Station heat rate 11,400 Btu per kwhr net output



By **WILLIAM C. ROWSE** and **JOHN PAUL STRATFORD**
Engineer of Steam Design, *Engineer of Station Design,*
Department of Water and Power, The City of Los Angeles, California

DURING THE WAR, governmental restrictions on the use of critical materials made it impossible for the Department of Water and Power of the City of Los Angeles, California, to proceed with its planned construction program to provide for normal system growth. Furthermore, the expected recession in load following the end of the war failed to develop; instead, a continued and rapid increase occurred.

In 1945 load studies showed that the City could expect a load increase of approximately 225,000 kw within the next five-year period, resulting in a system peak about 110,000 kw greater than the installed capacity in 1945, and that if a serious power shortage was to be averted in this area during the 1948 winter peak, additional generating capacity would be required by that time.

The only possible way by which this could be obtained in time to meet the demand was by the addition of generating capacity at the Harbor Steam Plant. This plant is located in the Wilmington district and close to Los Angeles Harbor, which is the source of supply for the large amount of condenser circulating water required. The ultimate installed capacity is shown by the following table; of this amount, Units Nos. 1 and 2 are in operation and Units Nos. 3, 4, and 5 are now under construction.

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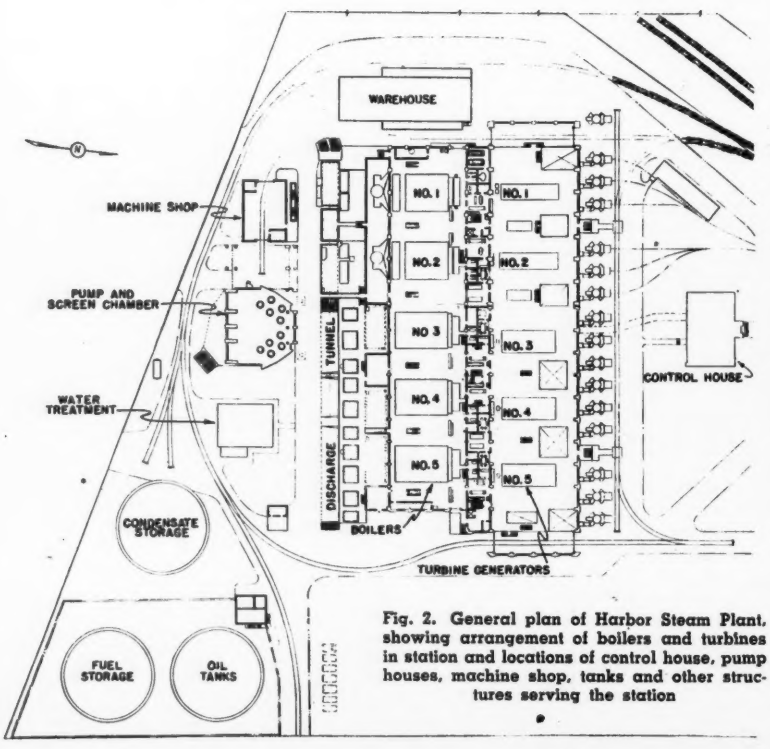


Fig. 2. General plan of Harbor Steam Plant, showing arrangement of boilers and turbines in station and locations of control house, pump houses, machine shop, tanks and other structures serving the station

WILLIAM C. ROWSE

Born in Davenport, Iowa, in 1883, Mr. Rowse received his B.S. degree in Mechanical Engineering from Purdue University in 1907, his M.E. in 1910. After a number of years of engineering experience with Cutler Hammer Mfg. Co., Franklin Automobile Co., Hog Island Shipyards (during World War I), together with wour years as instructor in engineering, University of Wisconsin, and two years starting a department of Mechanical Engineerfing at University of Manitoba, Mr. Rowse went to California in 1923. He first served as special assistant to the city engineer, City of Pasadena, joined the Los Angeles Department of Water and Power in 1926. For 12 years he was engineering assistant to the general manager and in 1937 was appointed to his present post. Since 1940 he has been building the organization to construct Harbor Steam Plant and recently has been directing studies for future plants. He has been a member of ASME for over 35 years.

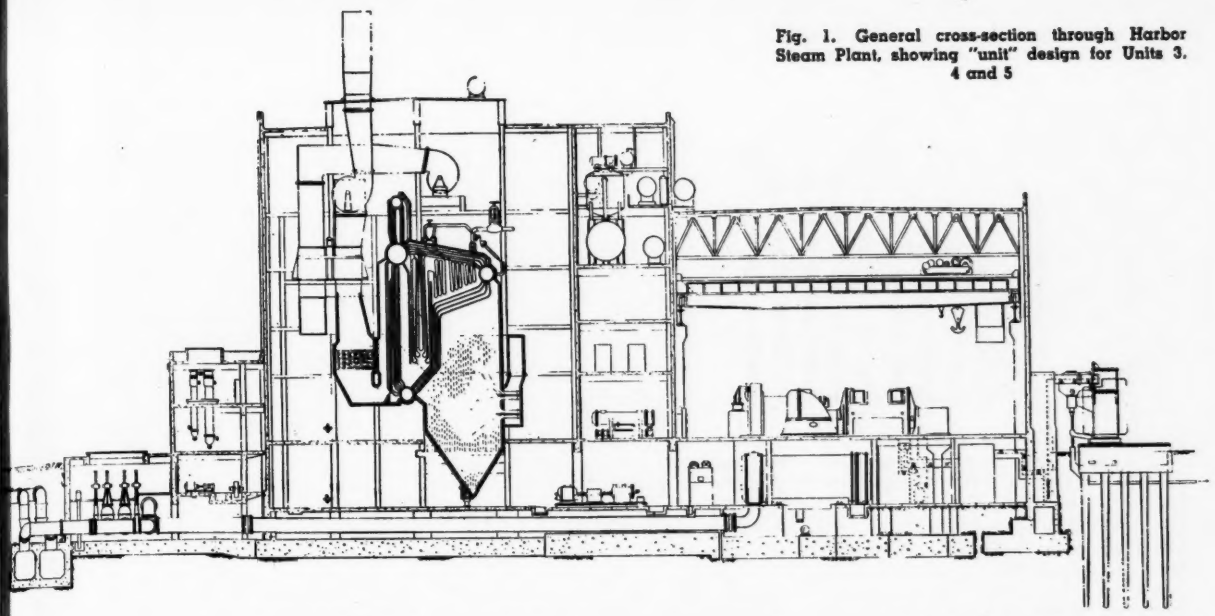


Fig. 1. General cross-section through Harbor Steam Plant, showing "unit" design for Units 3, 4 and 5

	Continuous Rated Capacity	Actual* or Scheduled Date of Initial Operation
Main Unit No. 1	65,000	June 1943*
House Unit No. 1	4,000	
Main Unit No. 2	65,000	November 1947*
House Unit No. 2	4,000	
Main Unit No. 3	75,000	November 1948
Main Unit No. 4	75,000	November 1948
Main Unit No. 5	75,000	February 1949
Total	363,000	

Units Nos. 1 and 2 are practically duplicates and since Unit No. 1 has already been described in previously published articles† only a brief review will be made here regarding these first two units.

Units Nos. 1 and 2, shown in Fig. 3, are both designed for a wide range of load, from operating continuously as spinning reserve at a very low load, with the ability to pick up full load instantly in case of necessity. These units are designed primarily for use as spinning reserve and as soon as load conditions permit will be operated at light load ready for quick pick-up. Due to present circumstances, however, it is necessary to use these generators as block load machines. There is one boiler for each main turbine generator unit. Each unit is provided with a small steam turbine generator unit for furnishing energy to station auxiliaries, thus assuring a constant voltage and frequency independent of system disturbances.

In the completion of the Harbor Steam Plant by the addition of Units Nos. 3, 4 and 5, the same fundamental type of design was followed as was used for Units Nos. 1 and 2. This comprised the "Unit" design, illustrated in Figs 1 and 2, wherein each turbine generator is provided with its own boiler, auxiliaries, switchgear, transformer bank and high voltage cable for connection into the Department's distribution system.

A number of considerations affected the decision on the general characteristics of Units Nos. 3, 4, and 5. It was decided these units would be block load units with a continuous capacity of 75,000 kw each and that there would be no special provision for quick pick-up of load.

After a careful study of the fuel situation, it was decided that the steam generating units would be designed for obtaining full capacity with

†Harbor Steam Plant Goes on the Line, by Charles P. Garman and William C. Rowse, POWER PLANT ENGINEERING, June, 1943; Details of 65,000-kw Harbor Steam Plant Turbine, by C. D. Franck, *Ibid*, February, 1945; The Harbor Steam Plant Boiler, by Max H. Kuhner, *Ibid*, June, 1945.

JOHN PAUL STRATFORD

Born in Cincinnati, Ohio, in 1900, Mr. Stratford has lived in Los Angeles since 1915. After two years' study at California Institute of Technology, he entered Cornell University, where he received the degree of Electrical Engineer in 1924. In the same year, he joined the Department of Water and Power as a draftsman. From 1925 to 1944 he supervised the electrical design of power plants, receiving stations and offices, and other power system structures. He was then made office engineer in the Power Executive division and in 1946 was appointed engineer of station design, his present post. He is a member of the AIEE and of the Electric Club.

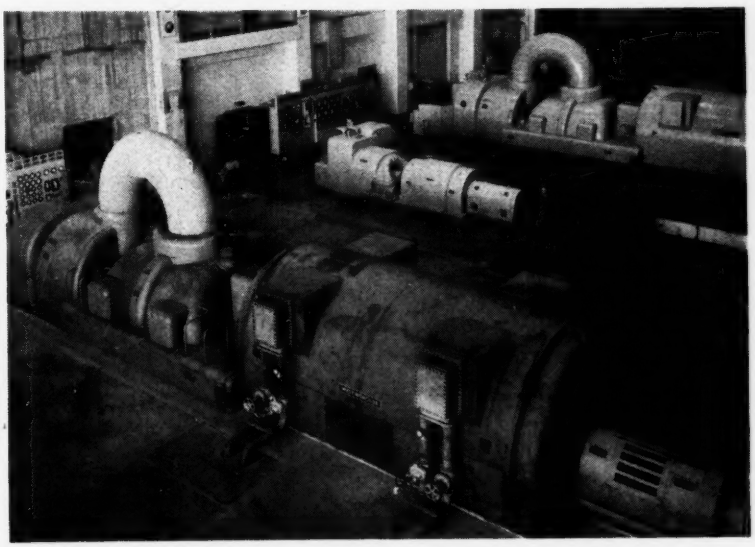


Fig. 3. View in Harbor Steam Plant turbine room, looking west and showing main turbine generator Units Nos. 1 and 2 with house turbine generator No. 1 between them. House Unit No. 2 is outside picture to left and new main Units 3, 4 and 5 also to left

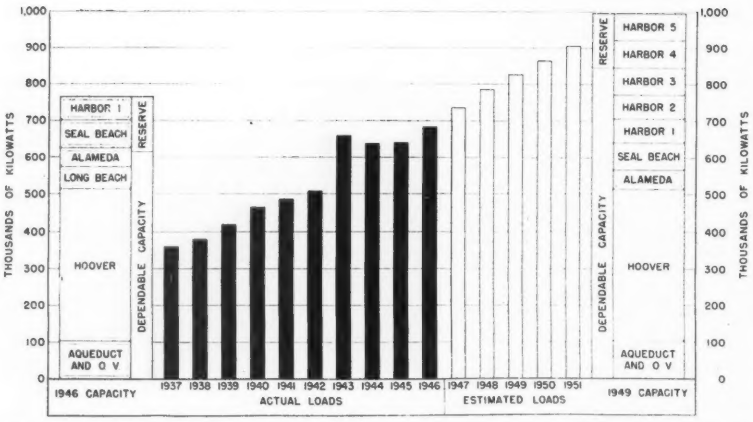


Fig. 4. Chart showing power system generating capacity and annual peak loads for City of Los Angeles, Department of Water and Power. (Half-hourly indicated readings)

oil or gas only, but with provision for burning pulverized coal in the future at reduced capacity. The requirement of reliability, as well as the economic studies, indicated continuation of steam conditions at the throttle of 850 psig and 900 F. Both 3600 rpm and 1800 rpm for the turbine generator units were thoroughly investigated and 1800 rmp was selected for several reasons, as follows:

Why 1800-RPM Units Were Selected

A 3600-rpm turbine of 75,000 kw rated capacity at 0.8 power factor would have to be of the tandem-compound type, with either double-flow exhaust with 23-in. blades in the last rows or triple-flow exhaust with 20-in. blades in the last rows, neither of which had been tried out in actual operation in the United States, whereas several 1800-rpm units of this size were in successful operation. At maximum capacity the leaving losses of the turbine, and consequently the water rate, would be greater with 3600 rpm than with 1800 rpm. While a boiler could be installed in two of the established 25-ft bays large enough for maximum load at 93,750 kw if 1800 rpm were used, the building bays would have to be increased for 3600 rpm. The electrical characteristics of the 1800-rmp generator were more favorable for the Department's system than those of the 3600-rpm generator, in that the slower-speed machines, with the greater inertia constant, provided increased transient stability for the system. Furthermore, the higher sub-transient reactance of these units reduced the short-circuit duty on the switchgear. These characteristics of the 1800-rpm units were the determining factors in their selection.

No house turbine generator will be installed initially, but provision will be made for future installation if it should be found necessary.

New Turbine Generator Units

The turbine of Unit No. 3, which is of the 17-stage impulse type, has a rated capacity of 75,000 kw with steam conditions at the throttle of 850 psig and 900 F and a back pressure of 1.5 in. Hg absolute. It is shown in Fig. 6. Guaranteed governor regulation for 50 per cent change in load is 2 per cent and guaranteed maximum overspeed permissible is 20 per cent. The turbine is equipped with a high load block, a low load block and an underspeed release on the low load block. Protection for the low pressure casing is by high exhaust pressure throttle trip device and by bursting plates. Steam is extracted at the 3rd, 6th, 9th and 13th stages for heating the feedwater to 400 F at 75,000 kw load.

The electric generator of Unit No. 3 is a four-pole, 60-cycle, 0.9-short circuit ratio, 3-phase, 13,800-v unit, with a nominal capacity rating of 93,750 kva, 0.8 power factor at 0.5 psig hydrogen pressure. A direct-connected exciter is used in conjunction with a static type voltage regulator and a motor-driven amplidyne generator. The main exciter is provided with duplicate brush holders to permit replacement of brushes while in operation.

The turbines for Units Nos. 4 and 5, which are of the reaction type with one high-pressure impulse stage and 32 reaction stages, each have a rated capacity of 75,000 kw with steam conditions at the throttle of 850 psig and 900 F and a back pressure of 1.5 in. Hg absolute. Guaranteed governor regulation for 50 per cent change in load is 2 per cent and guaranteed overspeed permissible is 12 per cent. The turbines are equipped with a high load block, a low load block, and an underspeed release on the low load block. Protection for the low pressure casing is by high exhaust pressure throttle trip device and by bursting plates. Steam is extracted at the 10th, 17th, 22nd, and 28th stages for heating the feedwater to 400 F at 75,000 kw load.

Generator Details

The electric generators for Units Nos. 4 and 5 are four-pole, 60-cycle, 0.9-short-circuit ratio, 3-phase, 13,800 v units, each having a nominal capacity rating of 93,750 kva at 0.8 power factor and 0.5 psig hydrogen pressure. Direct connected exciters are likewise used on these units but in these cases they are controlled by direct-controlled Rototrol generators, acting as pilot exciters. Duplicate brush holders are also provided on the main exciters for these generators.

All three steam generating units

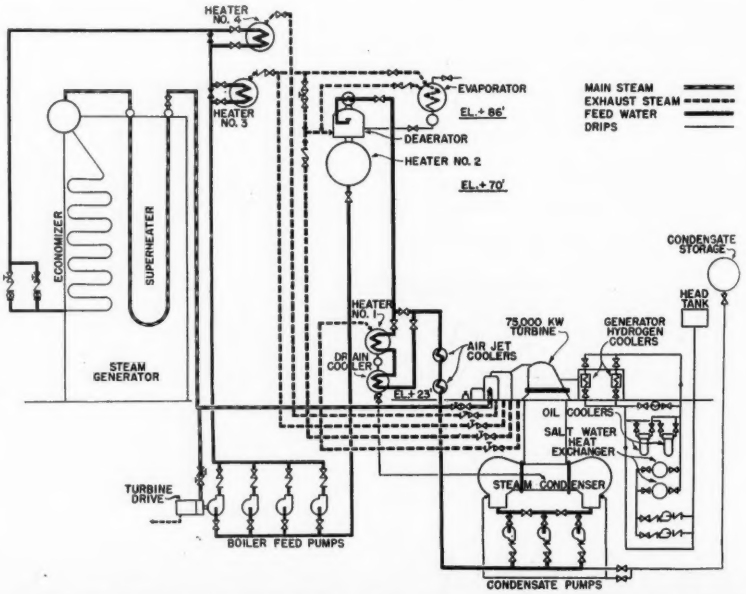


Fig. 5. Heat flow diagram for each of new Units Nos. 3, 4 and 5, Harbor Steam Plant. These three units have no interconnections. Hydrogen and lubricating oil coolers are out of condensate circuit and cooled with raw city water in closed circuit, with salt water heat exchanger, for reasons given in text

are identical and each consists of boiler, water walls, superheater, submerged-type desuperheater, economizer, regenerative-type air preheater and combination oil and gas burners, all enclosed in a metal covered setting. The boiler is of the three-drum bent-tube type, with a fourth or dry drum to prevent carry over of solids, as shown in Fig. 1. The superheater is of the pendant type, with an intermediate header from which part of the steam is diverted by an automatic device through the desuperheater, to maintain a constant steam temperature at the superheater outlet of 900 F ± 10 F for outputs of 425,000 lb of steam per hour or higher. There are 12 combination oil and gas burners (to which pulverized coal burners may be added) each having a capacity of 6000 lb of oil per hour. The furnace is surrounded by bare-tube water walls and is provided with a hopper bottom for ease in converting to pulverized coal burning.

The pressure on each boiler will be maintained constant at the superheater outlet at 900 psig. Since the boilers are not interconnected in any way, there are no non-return valves at the superheater outlets, but all pressure parts have been designed for a pressure of 950 psig at the superheater outlet in case of future interconnection and consequent installation of non-return valves.

Heat Balance

The three units have no interconnections and the heat flow of each unit is shown by the diagram of Fig. 5. The heaters are, in general, arranged one above the other, thus obtaining gravity flow for cascading drips. The deaerator is in the usual No. 2 position, since the units are not designed to operate at very low loads. The generator hydrogen coolers and the lubricating oil coolers are taken out of the condensate circuit and are supplied with raw city water in a closed circuit with a salt water heat exchanger. This accomplishes two results; namely, (1) constant temperature of water for hydrogen and oil coolers at all turbine exhaust pressures; and (2) the ability to use standard hydrogen and oil coolers.

The calculated overall heat consumption of the entire plant will be about 11,400 btu per kw hr net station output at 75 per cent of rated capacity, when burning oil.

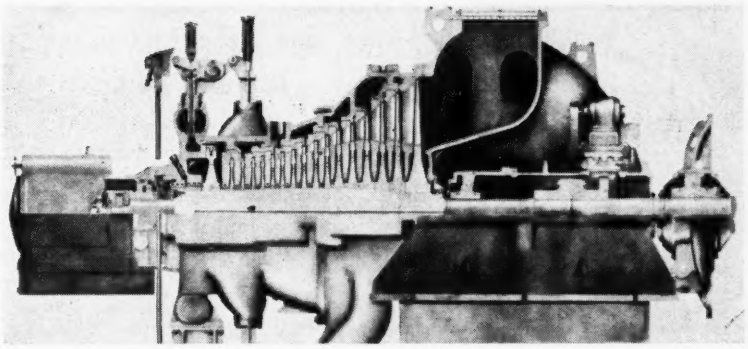


Fig. 6. Longitudinal section of 75,000-kw turbine, Unit No. 3, Harbor Steam Plant

Twin Main Steam Condensers

Since the twin main steam condenser on Unit No. 1 has proved entirely satisfactory in operation, this type of condenser has been used on all five units at the Harbor Steam Plant. Two half-size condensers of 35,000 sq ft each are installed longitudinally on each side of the low-pressure turbine with a connecting piece between the turbine exhaust and the two condensers. The advantages of this arrangement include:

(a) Low center of gravity of the turbine generator unit, which is favorable to foundation design, particularly against earthquake;
(b) Low broad foundation to support both turbine and condensers;
(c) Solid bolting of condensers to foundations, doing away with spring supports, expansion being taken care of by rubber fabric expansion joints between condensers and connecting piece;
(d) Main operating floor for both turbine and boiler on the same level.

Boiler Feed Pumps and Drives

The boiler feed pumps are centrifugal pumps of the barrel type with split inner casings. For each boiler there are four half-size pumps, each pump having a capacity of 940 gpm against a head of 3,230 ft with water at 295 F. One of the four pumps is driven by a variable-speed turbine and the other three pumps are driven by constant speed 3600 rmp, a-c motors, through variable-speed fluid drives. These drives were decided upon after an economic study of the following drives: (a) constant speed a-c motor, (b) variable speed with constant-speed a-c motors and fluid drives, (c) variable speed with wound-rotor motors and liquid rheostats.

Automatic Control

The condensate level in the hotwells is kept within desired limits by a make-up and draw-off system automatically controlled by floats in the hot-wells. Also, an automatic control maintains the temperature of the condensate leaving the jets at not greater than 100 F and recirculation of the condensate at low loads. The amount of condensate pumped through No. 1 heater to No. 2 heater is controlled by the water level in the No. 2 heater storage tank.

For automatic control of water level in the main steam drum of the boiler, the three-element control system equalizes the steam flow out of the boiler and the water flow into the boiler and corrects for water level in the main steam drum. The flow of boiler feedwater is controlled by the boiler feed pump variable-speed coupling (there is no regulating valve). A minimum flow from the boiler feed pumps is maintained by automatically-controlled by-pass valves.

Rate of firing and steam pressure at the superheater outlet are automatically regulated by one set of

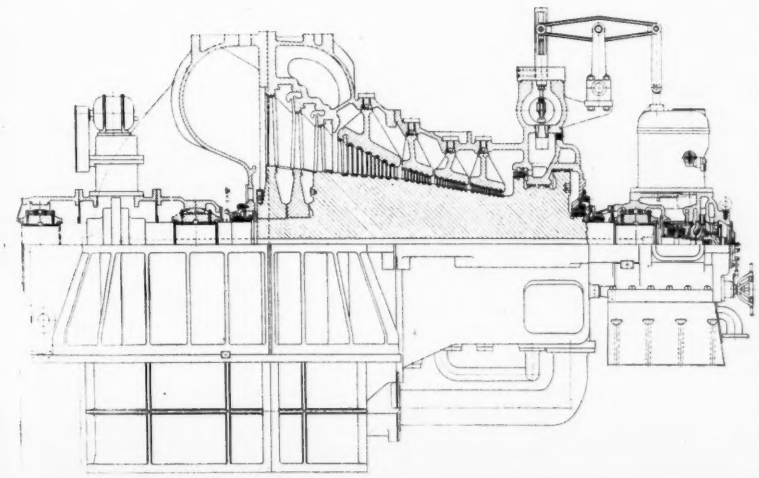


Fig. 7. Longitudinal section of 75,000-kw turbines, Units Nos. 4 and 5, Harbor Steam Plant

PRINCIPAL EQUIPMENT, HARBOR STEAM PLANT—UNITS NOS. 3, 4 AND 5

Department of Water and Power, The City of Los Angeles, California

STEAM GENERATING EQUIPMENT

Steam Generating Units: 3 Riley Stoker Corp. bent tube boilers; bare tube water walls, pendant type superheater; capacity each 650,000 lb steam per hr continuously, 825,000 lb steam per hr for two hrs; steam working pressures 900 psi constant at superheater outlet and 1200 psi maximum in main steam drum; steam temperature at superheater outlet 900 F at 425,000 lb steam per hr or more; heating surface per unit sq ft—boiler 23,980, water walls and floors 6835, superheater 29,000, economizer 7000. Two Air Preheater Corp. Ljungstrom air preheaters 158,000 total; furnace volume 26,000 cu ft; 12 Peabody Engineering Corp. Type H-26 combination oil and gas burners

Automatic Controls: Bailey Meter Co.; air-operated; combustion control, boiler feedwater control, by-pass recirculation of boiler feed water and condensate system control (make-up and draw-off)

Fuel Oil Service Pumps: 6 Sier-Bath Gear & Pump Co., Inc., size H internal screw pumps; each 150 gpm; 3 driven by two-speed 870-435-rpm, 125-hp G.E. motors; 3 driven by G.E. 125-hp constant-speed motors—870 rpm

Fuel Oil Differential Pumps: 6 constant differential pumps, United Iron Works; size 2 in. MSA 6-stage, direct connected to 60-hp Westinghouse motors, capacity each 135 gpm against a differential pressure of 300 psi, discharge pressure 900 psi

Induced Draft Fans: 6 B. F. Sturtevant Co. (Westinghouse) radial tip; guaranteed capacity each 195,000 cfm at 12 in. water, 360 F, 880 rpm, with vane control. Each driven by a two speed a-c motor (see Fan Drives)

Forced Draft Fans: 6 B. F. Sturevant Co. (Westinghouse) backward curved; guaranteed capacity each 135,000 cfm at 16 in. water, 120 F, 1175 rpm with vane control. Each driven by a two speed a-c motor (see Fan Drives)

HEATERS AND PUMPS

Closed Low-Pressure Heaters: 3 Westinghouse Electric Corp. horizontal, straight tube, floating head with 3 drain coolers; each No. 1 heater 2450 sq ft, ¾ in. 18 BWG admiralty tubes; each drain cooler 410 sq ft, ¾-in. 18 BWG admiralty tubes

Closed High-Pressure Heaters: 6 Westinghouse Electric Corp. horizontal, removable bundle, U-tube, four-pass, locking-head; 3 No. 3 and 3 No. 4 heaters identical; each 2700 sq ft, ¾ in. 15 BWG 70-30 copper nickel alloy

Deaerating Heaters: 3 Permutit Co. spray-type 725,000 lb per hr, 48 psig, with 120,000 lb water storage; dissolved oxygen content guaranteed 0.005 cc per liter or less under all conditions

Evaporators: 3 Lummus Co. horizontal, submerged coils; each 17,000 lb per hr, 18 BWG 80-20 cupro-nickel tubes

Water Treatment Plant: 4 Permutit Co. pressure type carbonaceous zeolite softeners (1 hydrogen zeolite and 3 sodium zeolite), 1 degasifying unit, acid and brine measuring tanks and appurtenances; total capacity 144,000 gal between regenerations, regenerative period 60 min

Water Filters: 4 Liquid Conditioning Corp. pressure type 72 in. diameter filters, with filter bed of anthracite coal, equipped with surface washers, and appurtenances for prefloc treatment

Boiler Feed Pumps: 12 (4 per unit) Byron Jackson Co. horizontal, centrifugal, variable speed 6 in., 11 stage barrel type, horizontally split inner casings; capacity each, 875 gpm deaerated condensate 295 F, 3230 ft dynamic head; 9 each driven by G.E. 1000 hp 3575-rpm 2300-v constant-speed motor through American Blower Co. variable-speed fluid drives and 3 each driven by a Westinghouse 1500-hp, single-stage variable-speed turbine

Horizontal Condensate Pumps: 9 (3 per unit) DeLaval Steam Turbine Co. centrifugal, 3-stage, split-casing, 1160 rpm; each 800 gpm, 91.7 F and 350 ft dynamic head; each driven by G.E. 125-hp, 460-v motor

Miscellaneous Pumps: 18 Dayton-Dowd Co. horizontal centrifugal pumps for oil and hydrogen cooler, boiler fill, condensate transfer, soft water booster, emergency gland seal, evaporator feed; 6 Peerless Pump Co. vertical turbine-type pumps for treated water, soft water and brine; 6 Pomona Pump Co. vertical turbine-type pumps for bearing cooling water, chlorinating water; 18 Simonds-American Marsh Co. vertical sump pumps

Pump Driving Motors: All 3-phase, 60-cycle, constant-speed, squirrel-cage motors unless otherwise listed

MAIN TURBINE GENERATORS AND AUXILIARIES

Main Turbine Generator No. 3: 1 General Electric Co. 1800-rpm turbine, 75,000 kw at 0.8 pf; 17 impulse stages, bleeding at 3rd, 6th, 9th, 13th stages. Nominal throttle steam 850 psig, 900 deg F, back pressure 1.5 in. Hg abs; 4-pole hydrogen-cooled generator, 93,750 kva at 0.5 psig hydrogen pressure; 13,800 v, 3 phase, 60 cycle, 0.9 short circuit ratio; direct connected exciter 300 kw, 250 v; amplidyne voltage control

Main Turbine Generators Nos. 4 and 5: 2 Westinghouse Electric Corp. 1800 rpm turbines, each 75,000 kw at 0.8 pf; 1 impulse stage, 32 reaction stages, bleeding at 10th, 17th, 22nd, 28th stages. Nominal throttle steam 850 psig, 900 F, back pressure 1½ in. Hg abs; 4-pole hydrogen cooled generator, 93,750 kva at 0.5 psig hydrogen pressure; 13,800 v, 3 phase, 60 cycle, 0.9 short circuit ratio; direct connected exciter 300 kw, 250 v; rototrol voltage control

Lubricating Oil Purification System: Bowser, Inc., continuous bypass system; 3-500 gph oil conditioners, one for each turbine generator; also central purification system consisting of 1-1000 gph oil conditioner, 1-1200 gph DeLaval centrifugal separator, 2-18 gpm oil polishing filters, and attendant pumps; 2-3000 gal rest tanks

Main Steam Condensers: 3 Condenser Service and Engineering Co., twin, horizontal, two-pass, surface condensers with connecting pieces; each condenser 35,000 sq ft, containing 5878, ⅞-in., 18-BWG admiralty and aluminum brass tubes, 26 ft effective length; 28,200 gpm cooling water to each condenser; rated performance 1½ in. Hg abs at 600,000 lb steam per hr total, (75,000 kw) with a cleanliness factor of 85 per cent; Muntz-metal tube sheets, cast-iron water boxes; deaerating hotwell; steam jet air ejectors for 850-900-psig, 900-F steam

Circulating Water Pumps: 6 Peerless Pump Co., 500-rpm, vertical, single-stage, mixed-flow; each 30,000 gpm salt water against total head of 32 ft; each driven by Westinghouse 350-hp, 500-rpm, 2300-v outdoor-type motor

Traveling Refuse Screens: 3 Chain Belt Co. screens; each 6 ft wide and 30 ft c to c of sprockets; each screen driven by Westinghouse 5-hp, 1725-rpm, 440-v, motor through 331.8 to 1 gear reduction

Air Compressors: 2 Worthington Pump and Machinery Corp. 300 cfm, horizontal, single cylinder, reciprocating; driven through Vee belts by G.E., 1800-rpm, 3-phase, 60-cycle, 460-v squirrel-cage electric motors

Power Piping: Designed and detailed by Department Engineers. Chrome-molybdenum pipe used for high temperature steam service. A106, grade B for boiler feed service. High-pressure high-temperature valves are A217 material, grade WC-3. Boiler feed valves are A216 material, grade WCB. Valves will be furnished by Chapman Valve Manufacturing Co., Manning Maxwell and Moore, and others. Power Piping System will be shop fabricated and material furnished and erected by Blaw-Knox Co. Circulating water lines comprise 42 in. centrifugal cast concrete pipe in the runs, with 42 in. standard C.I. fittings. Valves are 42 in. double-disc gates, motor operated. Circulating water system completely installed by M. F. Kemper Construction Co.

Chlorinating Equipment: Wallace & Tiernan Products, Inc.; automatic controlled type AHSV, capacity 36,000 lb chlorine gas per 24 hr; 11 point rate controller, automatic electric program controller; Pomona deep-well type chlorine injector supply pump, with automatic self-cleaning strainer. Tank car chlorine storage

TRANSFORMERS AND SWITCHGEAR

Main Power Transformers: General Electric Co. single-phase, outdoor-type, oil-immersed, power transformers, capacity 25,000 kva self-cooled, 33,333 kva forced-air-cooled. Six 76,200/132,000 Y — 13,200 Delta, three 20,000/34,500 Y—13,200 Delta and one spare for either secondary voltage

Generator Switchgear: 3 units Westinghouse Electric Corp. metal-enclosed switchgear equipped with Type 150 CA-2500 air circuit breaker, disconnect switches and potential transformers. Air circuit breaker rating 5000 amp 15 kv 3-pole, single-throw, 2,500,000 kva interrupting capacity; auxiliary air supplied by 2-type CA14 motor-driven compressors delivering 6.5 cfm, with approximate storage capacity of 540 cu ft free air at 250 psi

Neutral Switchgear and Reactor Cubicle: 3 units metal-enclosed switchgear with Kelman Electric and Manufacturing Co. Type 15 LA2-H-ID oil circuit breakers, 1200 amp, 15 kv single-pole, single-throw, 60,000 amp interrupting capacity and equipped with General Electric Type CLS-60 reactor, 54,500 kva at 1830 v, single phase, dry type, indoor

Auxiliary Power Transformers: 3 Pennsylvania Transformer Co. 3-phase, 60-cycle, outdoor-type, oil-immersed, self-cooled, power transformers, 13,200-2400 v, capacity 5000 kva

Auxiliary Power 2300-v Switchgear: I.T.E. Electric Co. type HV150 Multumite metal-enclosed, drawout-type switchgear, with 1200 amp, 5000 v, 150,000 kva air breakers in a total of 40 cubicals

Auxiliary Power 440-v Switchgear: I.T.E. Circuit Breaker Co. Multumite, indoor metal-enclosed switchgear employing drawout 600-v, a-c, 3-pole, single-throw, air circuit breakers, with an interrupting rating of 25000 amps in a total of 90 cubicals

Draft Fan Drives and Control: 2 General Electric Co. 2-speed 2300-v squirrel cage motors 800/500 hp, 900/720 rpm, for the induced draft fans and two 600/300 hp, 1200/900 rpm for the forced draft fans on each boiler unit. Regulation of draft for exact boiler requirements by means of Bailey control, operating inlet vanes on the fans

Traveling Crane, Power House: 1 Cyclops Iron Works and 1 Whiting Corp. cranes. Each 125-ton, 94 ft span; main and auxiliary hooks. Main hook capacity 125 ton, travel 5 fpm; auxiliary hook capacity 25 ton, travel 20 fpm. Bridge travel 150 fpm, trolley travel 75 fpm; each hook and hoist designed for 25 per cent overload

Traveling Crane, Screen and Pump Chamber: Cyclops Iron Works 25-ton traveling crane. 57 ft span. Main hook capacity 25 ton; auxiliary hook capacity 5 ton

Auxiliary Driving Motors: All 3-phase, 60-cycle, constant-speed, squirrel-cage induction motors unless otherwise listed

Load and Frequency Control: Leeds and Northrup Co. Master Frequency Standard and Master Time Standard arranged to provide control of frequency, time error, or tie line loading for the entire plant or for any individual unit

Station Storage Batteries: 2 Electric Storage Battery Co. Exide Type FM-17 storage batteries, 120 cell, 640 amp-hr, 250 v. One Gould Storage Battery Co. Type OPE 517 storage batteries, 120 cell, 640 amp/hr, 250 v. One Exide Type DMGO-17, 34 cell 60 amp-hr, 68 v

Motor Generator Charging Sets: 2 Westinghouse Electric Corp. Type CS-SK, 10 kw. One General Electric Co. Type CD-67-10kw-R-326-4-15 hp

Communication and Alarm Systems: Automatic Electric Co. 100-line PAX telephone system with code call equipment; manual telephone system designed and built by the Department of Water and Power for direct communication between the control house and the turbine and boiler control boards; alarm system designed and built by the Department of Water and Power consisting of illuminated-front panel annunciators

Fire Protection: Cardox Corp. low-pressure CO_2 system containing 4 tons of refrigerated CO_2; Oil Field Construction Co. foam system which includes two bins and hoppers, three generators with 20,000-lb powder storage in hoppers and 20,000-lb can storage, six hose stations, three hose carts, three foam applicators on each fuel oil storage tank; high-pressure water booster pump for foam system

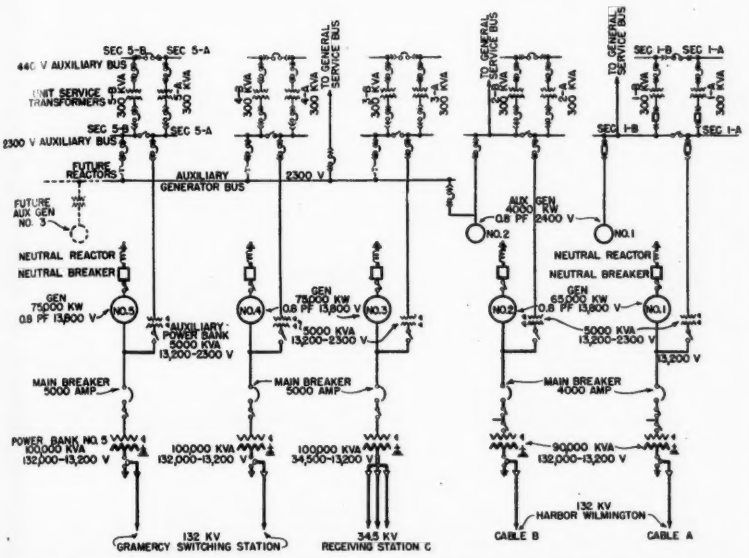


Fig. 8. Single-line wiring diagram for Units 3, 4 and 5, Harbor Steam Plant, showing bus and switching arrangements, provisions for supplying auxiliary power, direct generator connection to individual transformer banks. Unit 3 power transmitted directly at 34.5 kv, while Units Nos. 4 and 5 power is transmitted at 132 kv

automatic control equipment. The automatic master control responds primarily to a change in the rate of steam flow and secondarily to the resultant change in steam pressure. Upon any change of steam flow and through the operation of the master control, the rate of fuel flow and the output of the forced and induced draft fans are adjusted to maintain the correct operating conditions at all times. Following any operation of the master control, the fuel-air ratio and finally the output of the forced draft fans are corrected to maintain the proper furnace pressure.

The automatic combustion control utilizes standard, pneumatically actuated, fast-acting equipment and acts directly on the draft fan vanes.

Fans and Fan Drives

There are two forced-draft fans and two induced-draft fans for each steam generating unit, located on top of the structural steel supports, Fig. 1. This was done to leave the space above the basement floor to the rear of each unit available for future installation of pulverized coal burning equipment. Each forced draft fan has a maximum capacity of 135,000 cfm, 120 F, at 16 in. water and 1175 rpm, and each induced draft fan has a maximum capacity of 195,000 cfm, 360 F, at 12 in. water pressure and 880 rpm.

For Units Nos. 1 and 2, a radical departure was made from the usual practice in the method of driving the draft fans. The extremely wide range of operation of these units and the requirements for quick pick-up were reasons for selecting variable-voltage direct-current drives for these fans. These gave a speed range of 30 to 1 and extremely fast acceleration for quick pick-up.

For Units Nos. 3, 4, and 5 this extremely wide range of operation and the requirements for quick pick-up were not present.

Economic studies were made of the following fan drives: (a) one single-speed a-c motor per fan with vane control, (b) two single-speed a-c motors per fan with vane control, (c) one two-speed a-c motor per fan with vane control, (d) one single-speed a-c motor per fan with variable-speed hydraulic coupling, (e) one single-speed a-c motor per fan with variable-speed magnetic coupling, (f) one variable-speed a-c motor per fan, and (g) one variable-speed d-c motor per fan with motor generator sets. As a result of this study, it was decided to use one two-speed a-c motor with vane controls per fan, which gives a speed variation of about 1.3 to 1 and allows a load variation on the main generator of from 20,000 kw to full capacity.

The induced-draft fan motors are rated at 855/500 hp, 900/720 rpm and the forced-draft fan motors 600/300 hp - 1200/900 rpm. The lower speed will provide sufficient draft for the normal full load rating of the units of 75,000 kw with the vanes open, whereas the higher speed will provide for the maximum boiler requirements.

Main Electrical Equipment

The output of Unit No. 3 will be transmitted directly to the 34.5-kv load bus at Receiving Station "C", one of the Department's major receiving stations, located about two miles north of the Steam Plant and serving the Harbor area. Transmission will be by means of three 3-conductor, 1,000,000 - CM, low - pressure, gas-filled, lead - covered cables. The output of Units Nos. 4 and 5 will be transmitted on two separate 132,000-v circuits, one for each unit. These circuits will be partially underground and partially overhead steel tower construction. Power will be transmitted to a point approximately 13 miles distant, at which point it will be distributed into the 132-kv system supplying the Department's major Receiving Stations.

Following the basic design of the Harbor Steam Plant, each generator has an individual bank of transformers. Power is generated at 13.8 kv, and stepped up to 34.5 kv for Unit No. 3 and 132 kv for Units Nos. 1, 2 4, and 5. It was desired to purchase and maintain only one spare transformer, which could be used to replace any transformer that might fail on any

Fig. 9. Artist's conception of appearance of Harbor Steam Plant when completed, looking from the North

of the five units. The spare transformer was designed therefore, to step up from 13.8 kv to either 34.5 or 132 kv.

The generators are connected directly to the transformer banks through 13.8-kv circuit breakers, as shown in Fig. 8. The 13.8-kv bus was designed to be totally enclosed and phase isolated by transite barriers. The 13.8-kv generator circuit breakers are of the air-blast type with a rated interrupting capacity of 1,500,000 kva. They are housed in steel cubicles, which also contain the disconnecting switches for the bus feed to the main transformer banks, the disconnecting switches for the bus feed to the auxiliary power transformer banks, the potential transformers and the necessary compressed air facilities for operating the breakers. The air-blast type circuit breaker was selected because of space limitations, and to reduce the fire hazard of oil circuit breakers within buildings.

Each main transformer bank has a rating of 75,000 kva self-cooled, 100,000 kva forced-air cooled, the latter rating sufficient to carry the maximum kilowatt output of each unit. On each transformer, all bushings are enclosed and a special oil filled compartment houses the 132,000-v cable terminals as well as a disconnecting and grounding switch, thereby eliminating all hazard from bushing flashovers due to salt fog and dirt conditions. The banks are connected delta on the low side and Y on the high side with a solidly grounded neutral.

Auxiliary Electrical Equipment

Power for each unit's auxiliaries is normally supplied by a 5000-kva, 3-phase, 13,800 - 2300-v transformer connected to the generator bus, Fig. 8. To assure the utmost reliability on quick pick-up by Units Nos. 1 and 2, the 4000-kw turbine generator units are also installed to provide auxiliary supply for these units totally independent of other system disturbance. The house unit normally supplying Unit No. 2 is supplied with the necessary busing, so that its output may be made available for the auxiliaries of either Units Nos. 3, 4 or 5 in the event of failure of the transformer normally supplying these machines. In addition, an outside service from the Department's distribution system is supplied to the plant.

All auxiliaries are fed at either 2300 vor or 440 v, depending upon the size of the motors. Local distribution within the plant is at 2300 v with banks of 2300/440 v step-down transformers for the smaller auxiliary circuits. All motors rated less than 100 hp operate at 440 v, while those above 100 hp operate at 2300 v.

The main 2300-v station service switchgear is located in the auxiliary bay, Figs. 1 and 2. All feeder cables from this location to the various points of distribution throughout the plant are varnished cambric insulated with a Flamenol protecting sheath. The 2300-v switchgear is metal enclosed, equipped with removable truck-type air circuit breakers. Each circuit breaker has a rated interrupting capacity of 150,000 kva and was designed to meet the AIEE insulation and impulse requirements for breakers of 15,000-v classification.

The main 440-v auxiliary switchgear is also located in the auxiliary bay in a metal-enclosed structure that houses the 444-v but circuit breakers and cable terminals. The 440-v breakers are drawout - type air circuit breakers mounted on rollers, which permit their removal when the breaker is in the open position. These air circuit breakers have a rated interrupting capacity of 25,000 amp. Both the 2300-v and 440-v switchgears have sectionalizing switches in the center of the bus, with a source of supply feeding each bus section. The auxiliaries are distributed between the two respective bus sections, to permit maintenance without interruption of service.

Studies of all practical types of auxiliary drive indicated that electric motor drive should be employed wherever feasible because of its many advantages over other types. For simplicity of operation, freedom from trouble and minimum maintenance, the motors selected are single-speed, squirrel - cage, line - start, induction types designed for starting at 70 per cent voltages and guaranteed to carry full load for three minutes at this reduced voltage. Exceptions are the induced and forced-draft fan drives, which are two speed; and the fuel-oil service pumps, one of which is driven by a constant-speed motor and one by a two-speed constant torque motor.

Some of the auxiliary drive motors are of the open frame type, some the drip-proof type and some totally enclosed, fan-cooled type, selection being determined by duty and location of the equipment.

Control House

A separate Control House is located 150 ft from the main steam plant building, Fig. 2. This was done so that the operators having control of the plant output and all essential electrical equipment would be isolated from noise and free of disturbance in the event of plant troubles. The building is of reinforced concrete construction, approximately 54 ft by 82 ft, two story with basement. It houses the control room, control batteries, protective relays, automatic telephone equipment and offices for the superintendent, chief electrical operator and the clerical personnel.

The Control Board is of the all-steel panel arc design. It provides for the control and indicating metering of the five main turbine generator units, the two 4000-kw auxiliary generators and for a possible future house unit. Controls of the auxiliary buses and recording meters are located on other straight panel boards adjacent to the main control board.

Structural Features

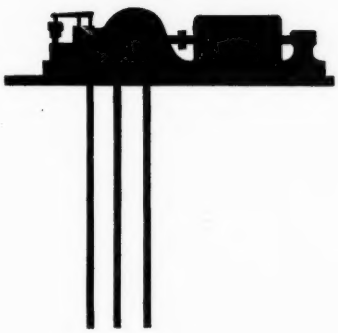
The Harbor Steam Plant is located in an area previously filled to a depth of 15 ft by material dredged from the harbor. This, plus the requirement that the structures must be capable of withstanding seismic forces, presented additional structural design problems. It was necessary to place the foundations approximately 25 ft below grade to secure suitable bearing capacity. All exterior walls are carried on a continuous footing around the building; the interior walls and boiler foundations are designed as a single continuous mat footing. Each turbine generator unit is carried on a separate reinforced-concrete foundation independent of the rest of the building, and massive in design so as to minimize the machine vibrations and prevent their transmission into the main building structure.

This building is of reinforced concrete with structural steel frame and provides approximately 133,000 sq ft of operating floor area. It contains about 60,000 cu yd of concrete, 3400 tons of reinforcing steel and 4800 tons of structural steel frame. It is 104 ft high at its highest point, 485 ft long and 300 ft wide.

In order to withstand seismic shock, the entire structure was designed for a horizontal force equal to 0.133 g or more. The floors in the turbine generator and boiler rooms were designed for 300-lb live load and those in the Auxiliary Bay for 150-lb live load. Provision was also made, of course, for concentrated equipment loads.

The plant is supplied with two 125-ton cranes, each equipped with a 25-ton auxiliary hook and designed for 25 per cent overload. No windows are used in the building and the Turbine Generator Room is lighted by combination incandescent and mercury lamps, thus simulating daylight. Three automatic passenger elevators are provided to facilitate operation of the equipment in the plant between elevations 4.5 and 86. For convenience in handling transformer oil, a piping system is installed between all transformer banks and the oil tanks and filtering equipment house.

in addition to the aforementioned Control House and Main Building the project includes the following reinforced concrete structures; a cooling water discharge structure, a pump and screen chamber, water treatment building, fire protection building, machine shop, fuel oil pump house, transformer oil tanks and pump house, and a warehouse. These combined structures will result in the use of approximately 80,000 cu yds of concrete for the entire project. Two fuel-oil storage tanks and a distilled water storage tank are also located on the site.



Few engineers in industrial plants need to be told of the advantages of steam turbines as sources of power for such plants. The difficulty often, however, is in making the plant owner or manager to "see" these advantages and to induce him to install these machines. This article, therefore, is aimed primarily at the plant owner or executive; it tells in simple language how great savings can be made in the use of the proper type of steam turbine in specific industries

Facts About STEAM TURBINES for Industrial Plant OWNERS

By GLEN D. FARRAR
General Electric Company, Schenectady, N. Y.

ONE TO TWO YEARS are required to get an industrial power plant into operation after the decision is made to go ahead with it. It will turn out power in the manner for which it was designed for years and years. Generally, it will be written off long before it is worn out—and with good reason. The amortization rate varies considerably in different companies, but it must be conservative enough to anticipate possible obsolescence due to major changes in their manufacturing business. Fortunately, turbines wisely applied can be well-adapted to changing conditions. That retirement date will be prolonged proportionately with how well the product, its method, rate, and quantity of manufacture are anticipated.

Let's look at the most apparent application first — using waste heat. Some industrial plants have boilers which generate steam for practically no cost. The fuel may be "black liquor", bark, bagasse, or any such by-product that must be disposed of and can be burned. Since the largest item in generating power with a turbine is fuel, a reduction of this item to zero with waste-heat boilers obviously makes a perfect turbine application.

Now, consider the plant that must buy its fuel.

Generally speaking, where any appreciable amount of steam is used in an industrial's process, it is cheaper to generate electricity as a by-product than to buy it from a utility. This is done by putting the steam through a turbine first, then into the process. In this manner, a turbine, properly applied skims off just what heat it needs for generating electricity and sends the bulk of the heat on to do the bigger job of heating something in the industrial's plant.

Paper mills, pulp mills, sugar mills and textile finishing plants are good examples of industries that use large amounts of steam in their cookers, digesters, driers, etc., as well as for space heating. They usually find that they can make power as a by-product cheaper than they can buy it.

On the other hand, machine-tool manufacturers, steel mills, foundries, aluminum plants, shipbuilders and textile mills without finishing equipment, usually use very little steam in their manufacturing processes; therefore, they generally find it cheaper to buy power from a utility.

Reference has been made to a turbine skimming off just what heat it needs. That sounds as though not much heat is required to run a turbine, doesn't it? Well, that's exactly right, and the amount of heat remaining in the steam leaving its exhaust is inevitably large. When this exhaust steam is utilized, the overall cycle efficiency is greatest. As a matter of fact, the differences in efficiencies between one turbine and another are surprisingly small compared to the differences in efficiencies between

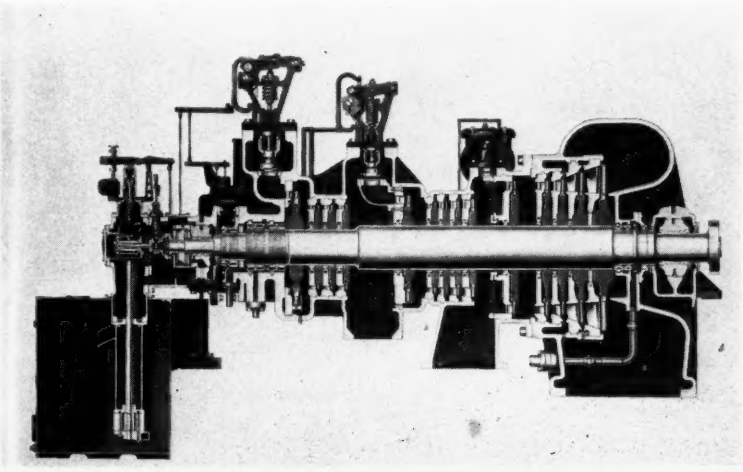


Fig. 1. Double-automatic extraction steam turbine

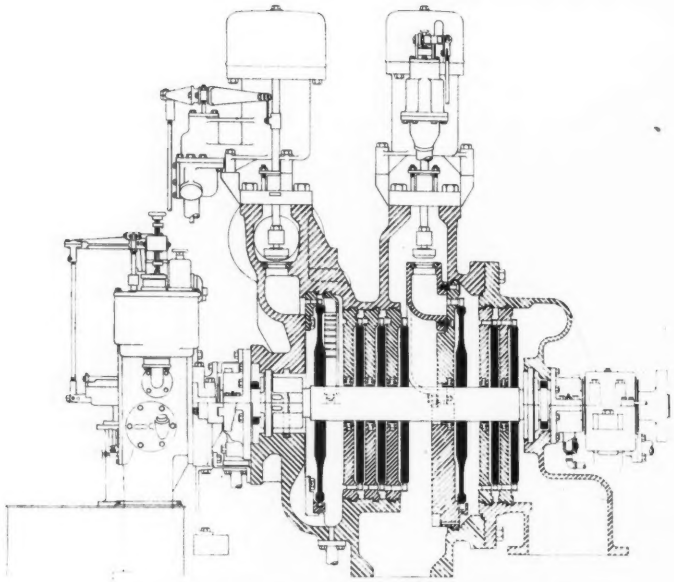


Fig. 2. Non-condensing single automatic extraction steam turbine

various heat cycles in which turbines are used.

An industrial plant often has a boiler putting 1000 Btu in each pound of water circulated to evaporate it into steam, so their process can (neglecting losses) get the 1000 Btu by condensing this pound of steam back into water. If enough (12 per cent) more fuel were burned in a boiler to put out 10 per cent more heat, then each pound of steam leaving the boiler would contain 1100 Btu. Its pressure and temperature would, of course, be raised proportionately. With this steam flowing through a turbine-generator set, the extra 100 Btu per lb with a flow of 100,000 lb per hr will produce over 2100-kw for a fuel cost of only two mils per kwh, *and* the process will get clean steam containing the same amount of heat it was getting before!

With greater flow, more kilowatts can be generated with the same steam conditions; and, if the steam conditions are raised, more kilowatts can be generated with the same flow. In applying turbines to industry, the flow is already established by the process requirements, so proper steam conditions are selected to give the required electrical power.

Ratio of Steam Use to Electrical Load

In connection with the forecasting problem mentioned earlier, the trend in nearly all industrial plants is to use more electricity in proportion to the steam requirements. Therefore, the turbine's initial steam conditions should be established sufficiently high at the out-set to provide for a reasonable steam-electrical balance in the future. Recently, I was in a plant which is installing new processing equipment that will use three to four times as much electricity per pound of finished product as before. The general effect of this trend has been seen through the years (according to one manufacturer's records, which are probably representative of the industry). In 1930 the average industrial turbine was designed for initial steam conditions of 240 psig, 500 F. This has climbed to approximately 500 psig, 700 F today. Incidentally, there are no physical limitations on turbines hampering this trend for steam pressures up to 2400 psig and temperatures up to 1050 F are in successful operation on machines where year-in and year-out reliability is paramount.

Higher initial steam conditions also favor probable trends in two more ways: (1) They permit sending steam to the process at higher pressures and temperatures. (2) They are better adapted to plant expansions, which would require additional turbine-generating equipment, and likely larger unit sizes.

Other things being equal, maximum over-all cycle efficiency occurs when the amount of steam flowing through the turbine is all required by the process. If this situation were maintained all the time, the industrial should undoubtedly have a straight non-condensing turbine, designed for this particular condition. The over-all cycle efficiency would be perhaps 60 to 75 per cent.

Minimum over-all turbine-cycle efficiency occurs when the steam from the turbine is exhausted to atmosphere. If this were done in the example previously mentioned, the over-all cycle efficiency would be only 5½ per cent.

Condensing Operation

To improve the cycle, the next best thing to do rather than discharge the exhausted steam at atmospheric pressure, is to make each pound of steam do more work in the turbine. This is done by exhausting into a vacuum, which is obtained by a condenser. The benefit is considerable. For example, the available energy between atmospheric pressure and a good vacuum is more than that between 200 psig and atmospheric. Another advantage is that the condensate is recirculated as boiler feed-water instead of being lost.

The disadvantage of this system is that the latent heat released when condensing the steam into water (often 1000 Btu per lb) is transferred to the condenser cooling water and thrown away because its temperature is too low to be of any practical value. The overall efficiency of a condensing-turbine cycle for an industrial plant

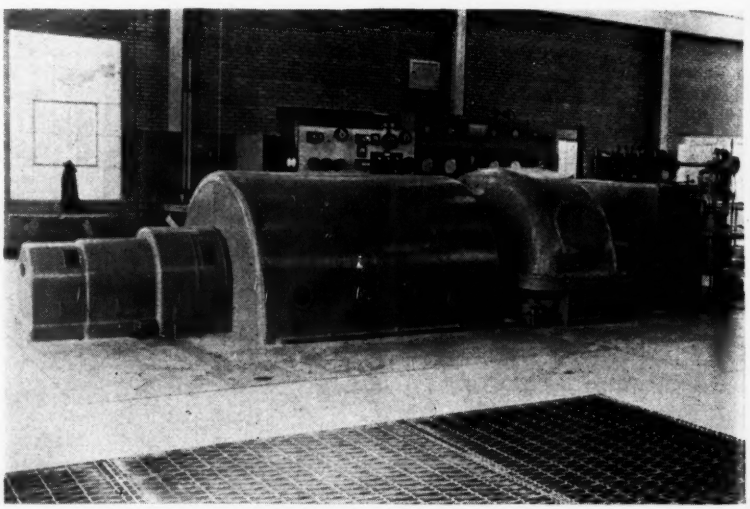


Fig. 3. 7500-kw turbine generator set installed in an industrial power plant

might be in the order of 25 per cent.

Large utility generating plants which make only electric power, use straight-condensing turbines, too, but with high pressures, high temperatures, several stages of regenerative feed-water heating, and complicated cycles in order to get this efficiency up. But the most efficient condensing plant in the world—with a turbine-generator efficiency of around 80 per cent—has an overall plant efficiency of less than 40 per cent! The bulk of the heat is thrown away through its condenser.

An industrial plant owner using no process steam is more likely to purchase power than try to generate it in the same manner as a large central station. Of course, there are exceptions due to unusual conditions such as long transmission lines, cheap fuel, etc. But he is not likely to enter the straight power-producing business because not only his load, but usually his load factor is considerably lower than that of a public utility, and he, therefore is not likely to be able to afford the necessary investment required to get his efficiency to that of the central station.

How to Meet Widely Swinging Loads

We have mentioned the two extremes—where the heat in the steam exhausting from the turbine is all used in the process, and where the heat in the exhaust is all thrown away. Conditions surrounding the problem of how best to obtain power for an industrial usually are somewhere, and most anywhere, between these extremes. So let's look further into how turbines can be applied, remembering that each situation must be evaluated on its own merits.

Where a straight non-condensing turbine is used, and a perfect steam-electrical balance occurs one minute, perhaps a minute later the steam flowing to some process is reduced, yet the electrical load continues as before. To meet swinging conditions like these, you might say the plant should install, in addition to this non-condensing turbine, a condensing turbine. Better yet, a single-automatic-extraction-condensing turbine could be used instead of these two turbines. It is, really, two turbines in one. Its initial cost is less and smooth automatic operation is obtained with its simple governing system. The extraction turbine, because it can carry load without process steam yet automatically keep the cycle efficiency high by using process steam whenever it is flowing, is a boon to hundreds of industrial plants. Its overall efficiency depends upon how much steam is extracted and how much flows all the way through the turbine, and may vary accordingly from perhaps 25 to 75 per cent.

Double Automatic Extraction Turbine

There are also double-automatic extraction turbines which maintain pressures in two different process steam lines, while also carrying the required electrical load. This is three turbines in one!

Many large industrials use several turbines of perhaps two designs. For example, they might have one or more straight non-condensing and one or more automatic-extraction-condensing machines. Thus a certain combination of turbines may be used to meet certain operating conditions, and another combination may be used to meet others, or they may all be used together. Frequently, one of the turbines having a condensing end will be used on week-ends.

Governing systems can be arranged to control pressures and loads in many different combinations in order to meet each customer's particular requirements.

Over 5 Million Different Turbine Designs Are Possible

From all the variables — initial steam pressure, initial steam temperature, extraction pressure(s) and flow(s) exhaust pressure and flow, governing systems, KW output—over 5,000,000 different turbine designs are possible within the ranges normally used by industrials. It is not surprising that very few duplicate machines are built, except for the same customer.

Modern manufacturing practice permits a reasonable price on these turbines by using standard parts which can be assembled in different combinations resulting in custom-built equipment.

You may ask, "Are that many different turbine designs necessary?" They are, as long as the requirements among industries vary because a change in turbine design can make a big difference in power generation costs. Turbines, properly applied, often pay for themselves in a few months, whereas, a turbine misapplied could be a liability even if the purchase price were zero. This becomes clearer when it is realized that the initial price of a turbine is small compared to the cost of steam flowing through it. It could cost $100 an hour to provide enough steam to flow through a $115,000 high-back-pressure turbine. In this example, steam costs in two months' time exceed the price of the turbine.

Reliability of Steam Turbines

Reliability of steam turbines makes them well-accepted, even in plants where a power outage means stopping production. A great many of these industries are so satisfied with the reliability of their turbine equipment that they do not provide any stand-by source of power. They plan a regular inspection period, say once a year, when all the equipment in the plant is serviced at the same time. If, on the other hand, the expense of a production stoppage is unusualy great, an extra turbine-generator set with adequate capacity to keep the plant running, is good insurance. It is not uncommon for a modern steam turbine to operate throughout the year constantly at its full capacity without appreciable deterioration of any of its parts.

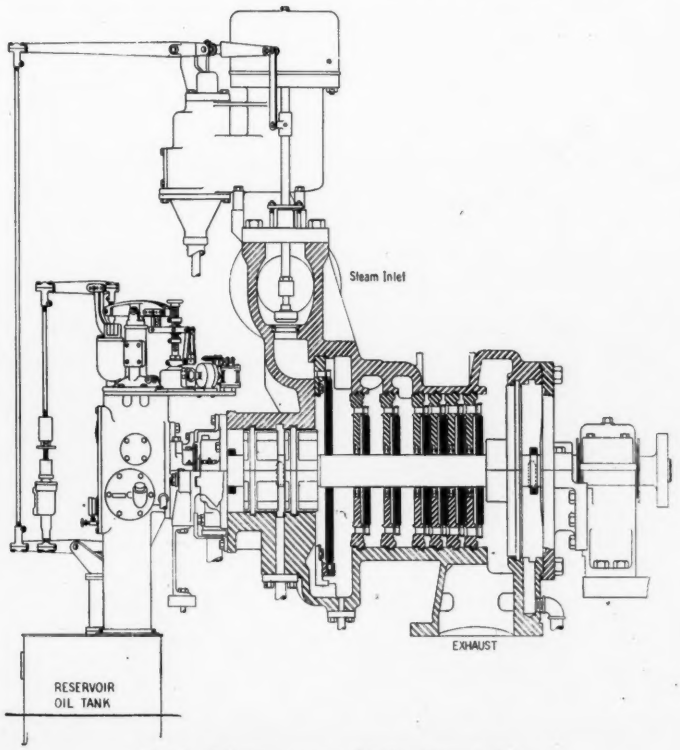


Fig. 4. A 7-stage non-condensing steam turbine

MIDGET MOTOR

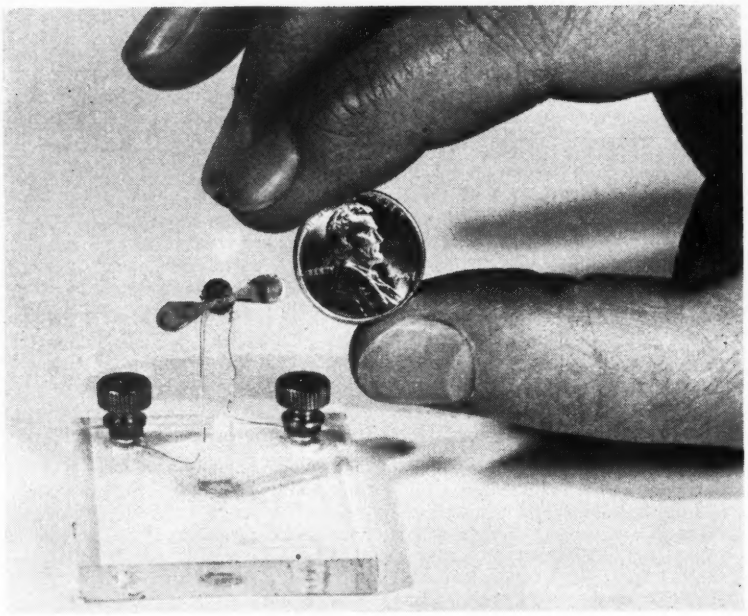


Fig. 1. World's smallest motor. The Electrotor, dwarfed by a penny is 3/16-in. wide, 3/16-in. in diameter, weighs under 1 gram, requires 1½ v. and runs at 7000 rpm

WHAT is no doubt the smallest electric motor in the world—so small that a half dozen fit easily inside an ordinary thimble—was demonstrated in the United States for the first time early this year. This motor is the tiniest of a series of sub-miniature direct-current motors invented by J. V. and J. E. G. Eurich, brothers of Lancashire, England. This motor, known as "Electrotor Type No. 001, weighs less than a gram, measures only 3/16 in. in length and diameter and operates on 1½ v. It is claimed that the efficiency is high. Running free it operates at 7000 rpm.

This particular motor is not commercial unit; it was built to show how small a motor could be built utilizing the Electrotor principles. It has three larger brothers, all useful, yet exceedingly small judged by ordinary motors. The smallest unit built for volume production is the Type 240, a motor that measures only 9/16 in. in width and ⅞ in. in diameter. It weighs a mere ¾ oz. This motor requires from 3 to 4½ v, consumes less power than a small flashlight bulb, and runs free at a speed of 5000 rpm.

These tiny motors were developed in England and have been used for many purposes, particularly in electrical toys. In this country they will now be manufactured by the United States Instrument Corporation on machines invented by the Eurich brothers. These machines have reduced manufacture to an operation almost entirely automatic. At the present time the U. S. Instrument Corp. has these motors available in volume quantities from Britain. They are being considered for use in such equipment as motion picture cameras and projectors, radio-controlled devices, battery operated electric shavers, etc.

As shown in Fig. 2 The Electrotor consists essentially of a permanent ring magnet *e*, a gap-ring armature winding *f* mounted on a bobbin *i* and spindle *j*, two end plates *b*, *b* with contacts *a*, *a* cover tape *c* and two securing clips *d*. The edges of the winding *f* are bared and the contacts *a*, *a* bear directly upon these edges. The winding *f* has a core of iron wires *g* of high permeability, cased in an insulating coat, upon which several layers of double Nylon covered copper wire *h* are wound in such a way that current flowing between the contacts energizes all the layers.

The principle upon which the motor works is as follows. Consider first the condition which obtains when no current is flowing, and the gap in the winding is adjacent to the S pole of the permanent magnet (Fig. 3 *d*). Both ends of the armature core have induced N polarity and the peripheral centre of the core (which is adjacent to the N pole of the magnet) has induced S polarity. When the current is applied (Fig. 3 *b*) the winding becomes, in effect, a horse-shoe electro-magnet with polarity between the points of contact of the contacts and the ends of the core (but with concentrated polarity at its ends), the end nearest the positive contact being a strengthened N pole, and that nearest the negative contact an S pole of reduced strength. Consequently, the N pole is attracted to, and the S pole repelled by, the S pole of the magnet, and rotation en-

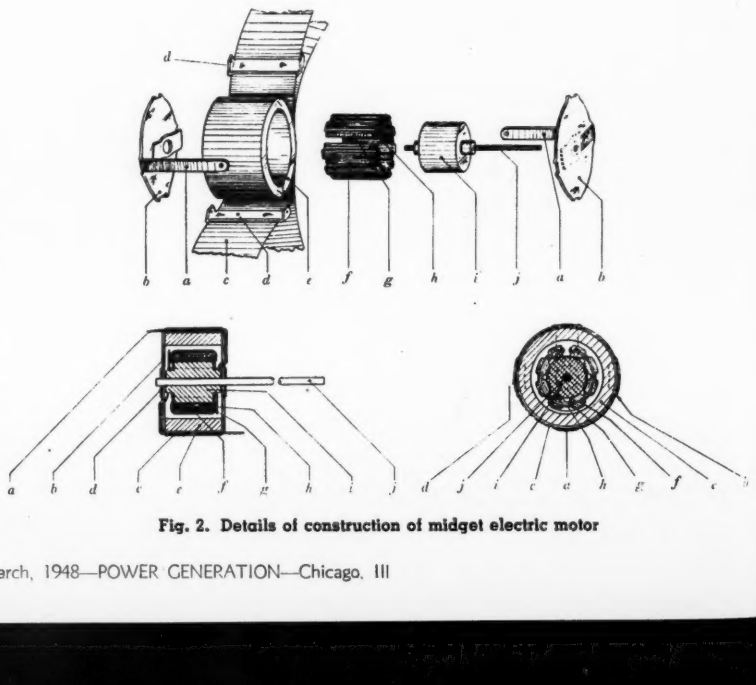


Fig. 2. Details of construction of midget electric motor

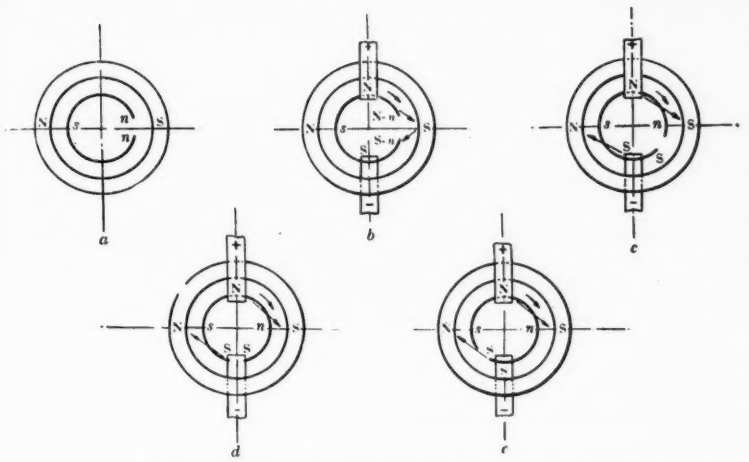


Fig. 3. Principles of electric motor. N, S energized polarity; n, s induced polarity

sues, the effective torque depending upon the width of the gap. As rotation continues (Fig. 3 *c*) the flux density of the N pole of the winding loses its end concentration and becomes more evenly distributed between the end of the contact point, and eventually has concentration at the contact point; conversely, the flux density of the S pole of the winding becomes progressively concentrated at the end of the core. There is, consequently, strong attraction to the poles of the magnet, with resulting high torque. The next stage to be considered obtains when both ends of the gap are under the negative contact (Fig. 3 *d*) and have therefore strong S polarity. The peripheral centre of the core (which is under the positive contact) is similarly of strong N polarity. Rotation therefore continues. The final stage occurs immediately after the gap has passed the negative contact (Fig. 3 *c*). The N pole of the armature is now concentrated under the positive contact, the terminal energized polarity being cancelled by the S polarity induced by the magnet. Consequently, the point of flux concentration is attracted to the S pole of the magnet. The folowing end of the armature, (i.e. that under the negative contact) has strong S polar concentration and is therefore strongly attracted to the N pole of the magnet. Thus at two stages in the cycle, flux concentration at one or other of the ends of the winding is utilized to give an additional surge of power, and the whole cycle is balanced by the constant variation in the distribution of flux density.

There are four sizes. The smallest (Fig. 1) is only 3/16 in. in diameter by 3/16 in. wide, and is thought to be the smallest electric motor ever made. It weighs less than 1 g. and requies only 1½ V., and has a speed of 7000 r.p.m. It can be used for special highly sensitive instruments. Three other types are ⅞ in. diameter, by 9/16. wide, 1½ in. by ¾ in. (taking 4½ to 6 V.), and 1½ in. by 1½ in. (taking from 6 to 24 V.). They have many uses, such as for air conditioning in trains and motor cas, for windscreen wipers, cine-cameras, projectors, toys, models, model aircraft, automatic razors, hairclippers and pocket fans.

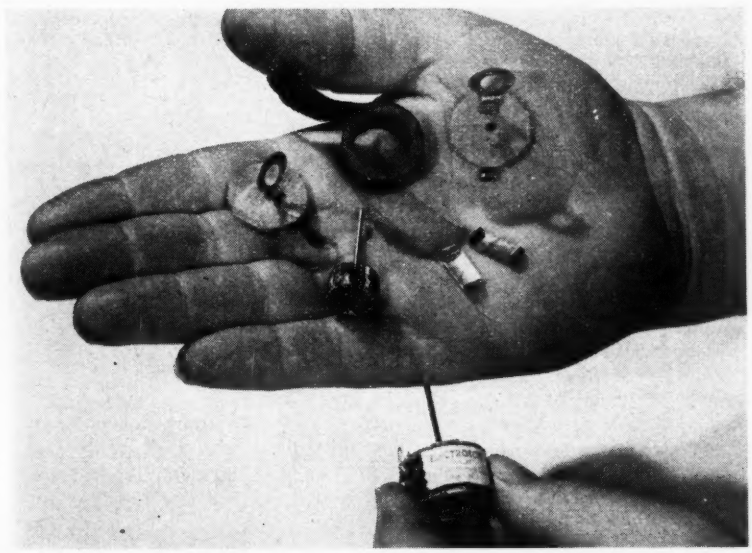


Fig. 4. All parts of the Electrotor (Type 240) scattered in hand. This midget weighs only ¾ oz, is 9/16-in. wide, ⅞-in. in diameter, runs at 5000 rpm and consumes less power than a flashlight bulb

FACTORS IN HYDRO PLANT CONSTRUCTION COSTS

AN 80 PER CENT increase in the productivity of workers in privately-owned electric light and power utilities, as against productivity of common and skilled labor which a recent survey found to be 36 per cent under prewar standards, is a key factor in checking the rising trend of operating costs in hydroelectric plants.

This was told to the American Society of Civil Engineers at its 95th Annual Meeting in Hotel Commodore by Milton G. Salzman, of Ebasco Services, Inc.

"Efficiency in design, construction and operation of new hydro plants must, of necessity, be the keynote if costs of generation are to be kept in bounds," Mr. Salzman said.

Pointing out that the stepped-up postwar tempo of the nation's business has created a "dire necessity of obtaining the most readily available source of plant capacity to keep pace with the rapid and abnormal load growth on most power systems," Mr. Salzman listed labor and material prices as the principal uncontrollable items affecting both investment and production costs, and added:

"There is no recourse but to accept the prevailing prices, as plants must be built and operated when needed."

Matters of engineering, which he listed among controllable costs are location of plant, size of installation, number and type of units, plant layout, selection and suitability of equipment.

Threat of coal and transportation strikes to curtail steam production of electric power has given development of hydroelectric projects a new impetus, Mr. Salzman said, and sites formerly considered economical, are again being reviewed.

As an example of economies effected by skillful engineering, simplified and improved design and coordinated layout together with improved efficiency and increased output of plants, Mr. Salzman cited a recent extension to a hydro station in the Northwest. Through installation of an addition to plant at a cost of about $58 per kilowatt, the over-all unit investment cost of the plant will be reduced from $148 to $103 per kw.

The Voltage Regulator— What to Expect of It

Voltage characteristics of a-c generators . . . Responsibilities of the voltage regulator . . . Sensitivity of the regulator . . . Factors which influence voltage dip due to a suddenly applied load . . . Factors which influence the time for the a-c voltage to return to normal following the sudden application of load . . . Recovery factors

By G. A. HANLON and R. E. LLOYD
Control Engineering Division, General Electric Company, Schenectady, N. Y.

Here is a good, practical discussion of the value of the voltage regulator. Just what can you expect of a voltage regulator? A voltage regulator is just what its name implies—a device to regulate, that is, maintain the voltage of the system under varying conditions of load and power factor. Like any other electrical device, however, the voltage regulator has to be applied intelligently. You just cannot stick a voltage regulator into any circuit and expect it to keep the voltage of the system constant within narrow limits under widely varying conditions of load. A voltage regulator has to be adapted to the system it is to serve. In this article two General Electric engineers discuss the problem in a practical and understandable manner

OFTEN a small or medium size power generating plant operator is faced with the problem of what to do about excessive voltage dips caused by picking up and dropping out large loads. This is especially true where he also has loads that cannot tolerate large dips. Many times the operator is of the opinion that a voltage regulator will solve this problem. Sometimes it will, sometimes it won't.

In the selection of a voltage regulator and excitation system, where sensitivity and response are required, a coordinated system design is a necessity. While this is applicable to all a-c generating systems, it is especially true for relatively small generating systems where the suddenly applied loads may be large compared with generator rating.

In the early years of the electrical industry, the inherent regulation of a-c generators was sufficient for all practical applications. The vibrating contact type of regulator was one of the first developments in the field of automatic regulation.

As the industry grew, regulating and excitation systems in general became more complex. The characteristics of the combined regulator, generator, and excitation system are so

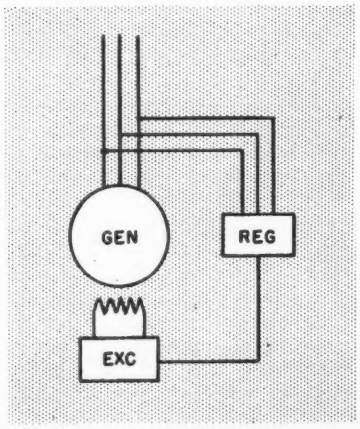


Fig. 1. A generating system composed of an a-c generator, regulator and exciter

Table I

Property or Characteristic	Influencing Factors	Responsibility
Sensitivity (at rated frequency and over specified frequency range)	Regulator	Regulator
Response (time to restore voltage to normal following sudden load application)	Regulator (regulator response and stabilization means) Generator (time constant) Exciter (rate of response)	Combined responsibility of regulator, generator and exciter
Voltage Dip (for a specified load suddenly applied)	Generator (transient reactance; open circuit time constant; synchronous reactance) Exciter (rate of response)	Predominately a generator responsibility
Stability (with regards the regulating loop)	Regulator (kind and amount of stabilization; regulator response time) Generator (time constant) Exciter (time constant)	Predominately regulator (although rigorous analysis will show that all time delays in the overall system are strong influences affecting stability)
Division of Reactive kva (between generators operating in parallel)	Regulator (sensitivity)	Regulator
Division of kw Load (between generators operating in parallel)	Governor characteristics of the prime-mover	Governors

dependent on the individual characteristics of each other that it is difficult, upon casual observation, to segregate individual responsibilities.

Figure 1 represents any a-c generating system composed of an a-c generator, regulator, and exciter.

The regulator may be any type—mechanical, impedance, or electronic. The exciter may be a conventional d-c exciter, a rotary amplifier (such as an amplidyne), or an electronic exciter (employing thyratrons or ignitrons). The a-c generator is a conventional machine. The following applies equally to any combination of these components.

Responsibilities of the Regulator

An a-c voltage regular, when tested with the generator and exciter, influences the action of the system in definite ways which can be measured, and for which the regulator is responsible. There are certain phenomena (especially during transients) which are observed over which the regulator has negligible control.

The regulator is completely responsible for sensitivity, or how close to normal does the regulator hold a-c voltage as load slowly varies from zero to rated load. (This check is made on a single generator with any reactive compensation circuits inoperative.) Where a-c generators are operated in parallel, the regulators are responsible for the division of reactive kva between generators.

The regulator has considerable control over the time for the a-c voltage to be restored to normal following sudden load application.

The regulator has negligible control over the dip in voltage experienced when a sudden load is thrown on a generator. It has no control over the division of kw load between two generators in parallel. This division is the responsibility of the governors of the prime movers.

Since the regulator has negligible effect on the magnitude of voltage dip, the factors which do have greatest influence are as follows:

(1) The a-c generator transient reactance (X'_d).

(2) The a-c generator open-circuit time constant (T'_d).

(3) The a-c generator synchronous reactance.

(4) The exciter response (volts/sec).

(5) The magnitude of the applied load.

(6) The power factor of the applied load.

The following qualitative statements show the relationships (graphically represented in Figs. 2, 3, 4, 5, and 6) between voltage dip and the foregoing factors.

The greater the generator transient reactance, the greater the voltage dip.

The longer the generator open circuit time constant, the less will be the voltage dip.

The greater the generator synchronous reactance, the more the voltage dip.

The faster the exciter voltage response, the less the voltage dip.

The lower the power factor of the load, the more the voltage dip.

To illustrate how little effect the regulator has on voltage dip, refer to Fig. 7 which is a comparison of two systems, one of which responds twice as quickly as the other.

Curve (x) represents the voltage decay if no regulator were present and a load drawing 50 per cent current at 0 power factor were applied to the generator terminals.

Curve (a) represents the voltage characteristic with regulator (a) which responds twice as fast as regu-

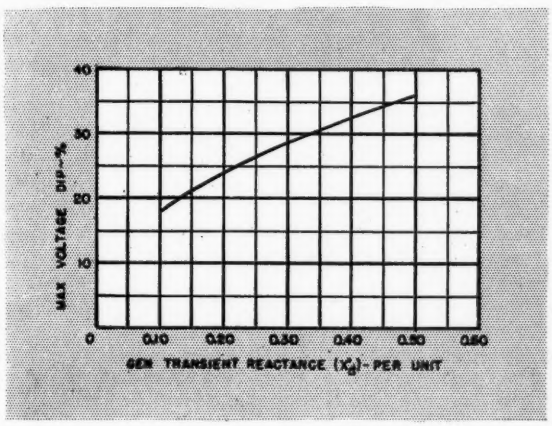


Fig. 2. Voltage dip vs transient reactance

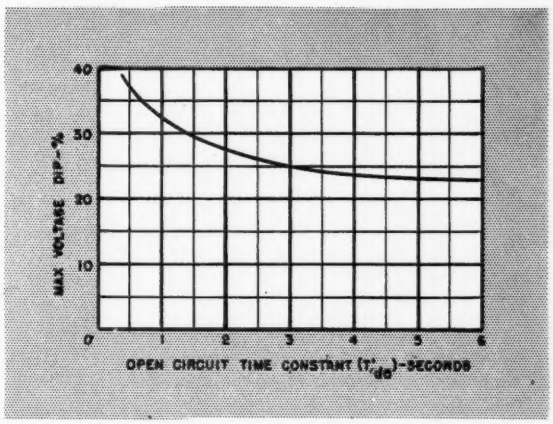


Fig. 3. Voltage dip vs generator open circuit time constant

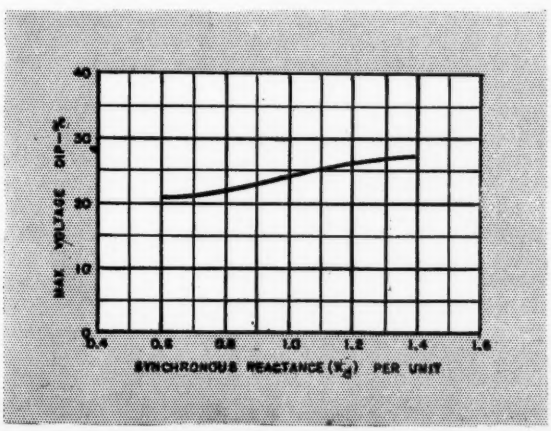


Fig. 4. Voltage dip vs synchronous reactance

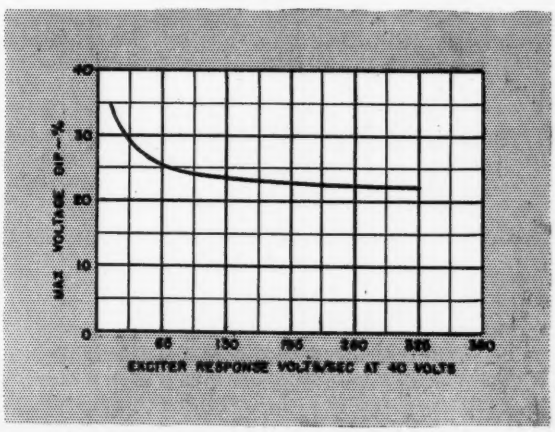


Fig. 5. Voltage dip vs exciter response

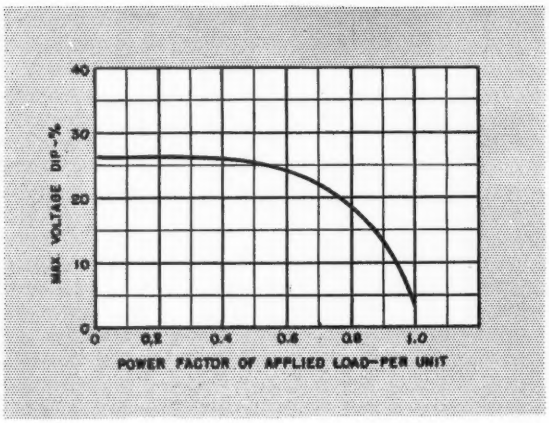


Fig. 6. Voltage dip vs power factor

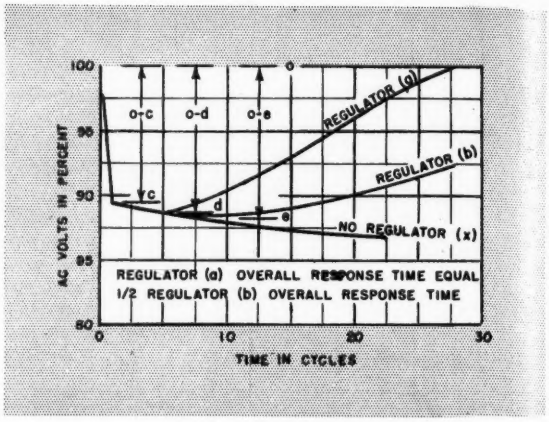


Fig. 7. Voltage dip vs response curves

lator (b), the characteristic shown by curve (b).

O-c represents dip due to transient reactance or 10.5 per cent.

O-d represents dip with regulator (a) or 11.1 per cent.

O-e represents dip with regulator (b) or 11.6 per cent.

c-d represents the additional dip in voltage over transient reactance dip due to regulator (a) or 0.6 per cent.

d-c represents the additional dip allowed by regulator (b) or 0.9 per cent.

Therefore, even though regulator (b) takes twice as long to respond, it only allows 0.3 per cent more dip than the faster regulator (a). This clearly illustrates that the regulator has negligible effect on the magnitude of a-c voltage dip following sudden application of load.

Factors Which Influence Time for A-C Voltage to Return to Normal Following Sudden Application of Load

As stated previously, the regulator has considerable influence over recovery time. However, other factors enter equally into consideration, making this characteristic of the system one of the most difficult to tie down with respect to responsibility.

The various important factors are:

(1) The amount and kind of stabilization used in the regulator.

(2) The generator open circuit time constant (T'_{do}).

(3) The exciter response.

These characteristics are shown graphically in Figs. 8, 9, and 10. Note that these curves were calculated for a hypothetical system and, therefore, should not be used quantitatively since they merely indicate trends.

Three definite conclusions can now be drawn concerning time of recovery. There is an optimum amount of stabilization for a given regulator which will give minimum recovery time. In addition, the generator open circuit time constant has considerable influence on recovery time—the greater the time constant, the longer the recovery time. Furthermore, the rate of response of the exciter affects recovery time; the faster the response, the shorter the time for the system voltage to be restored to normal.

For reference, Table 1 summarizes the characteristics and factors outlined previously.

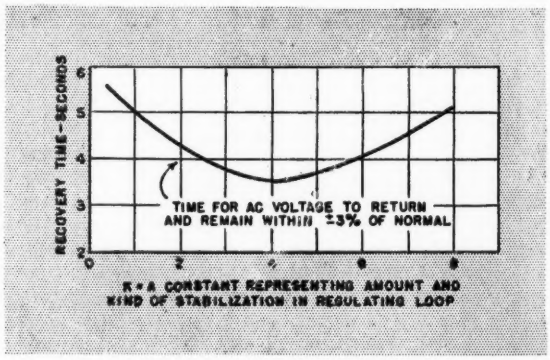

RECOVERY TIME-SECONDS
TIME FOR AC VOLTAGE TO RETURN AND REMAIN WITHIN ±3% OF NORMAL
R = A CONSTANT REPRESENTING AMOUNT AND KIND OF STABILIZATION IN REGULATING LOOP

Fig. 8. Recovery time vs. stabilization

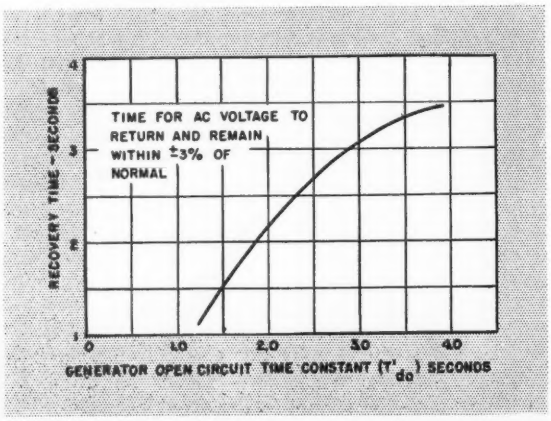

RECOVERY TIME-SECONDS
TIME FOR AC VOLTAGE TO RETURN AND REMAIN WITHIN ±3% OF NORMAL
GENERATOR OPEN CIRCUIT TIME CONSTANT (T'_{do}) SECONDS

Fig. 9. Recovery time vs generator open circuit time constant

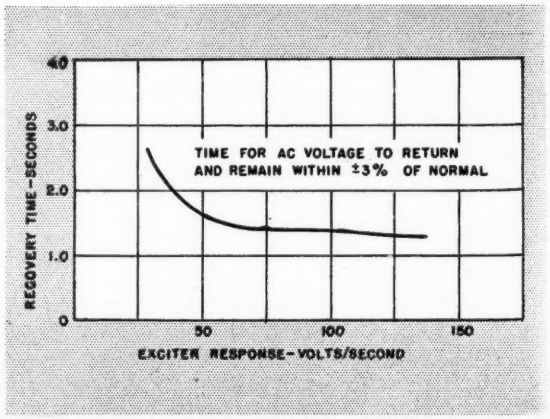


Fig. 10. Recovery time vs exciter response

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

☆

ARE YOU GETTING THE MOST OUT OF YOUR Q & A SECTION?

Several recent comments from readers have indicated that you can increase the value of your Q & A forum to yourself by doing two things:

1. **Try to ask questions clearly, definitely, coherently.**
2. **Give other readers some idea of how answers to your own questions have helped you.**

At the beginning of his answer to Question No. 385, October, 1947, issue, J. R. Darnell remarks on the fact that many questions are asked in an unclear way. The editors realize this, and are handicapped in publishing them because they cannot always take the long time required to correspond with the questioner to bring out:

a. **All the conditions under which the question came up;**
b. **All the necessary related information about equipment, its connections and operating conditions;**
c. **How much engineering knowledge the questioner already has.**

Seconding Mr. Darnell's comment, Wm. S. White suggests that perhaps in each issue some standard form of instructions or a data sheet would be published for asking questions. This would be very difficult to do, of course, for nobody can forecast just what form a question ought to take to bring out the required information.

A splendid illustration of this is the letter from G. H. Kimball, February issue, page 82, telling in detail how answers to his Question No. 328 helped him in solving his heating system problem about two years ago.

Since this is your section, you may have some ideas on the above, especially on this problem of whether any instruction form or data sheet for asking questions is feasible. If you like it is, we'll certainly try to work one out. Let's have your ideas about it.

☆

CONTENTS

Thread Cutting in the Lathe 72
By Carl Thomas

Blower Types Classified by Specific Speed 76
By A. M. G. Moody

Diesel Plant Layout with Auxiliary Equipment 78

Ten Commandments for Diesel Maintenance 79

Cleaning Used Ball Bearings 80
By Hudson T. Morton

How to Read Micrometers and Verniers 81
By John Foster

Letters and Comments 83
What to Do If the Water Level is Doubtful
He Says Spreader Stokers Don't Burn Sizes of Coal We Said They Did
Compressed Air System Explosions

Weight of Insulation for Pipes 86
By Sanford S. Ulrich and Thomas H. Dickson, Jr.

Questions and Answers 86
How are Creep Measurements Being Used?
What Methods Reduce Maintenance Outage Time?
How Do Different Coals Affect Precipitator Performance?
How Valuable are Pulverizer Recorders?
Could Spontaneous Ignition Have Caused This Explosion?—Correction Note
Should 115-V Extension Lights be Used Inside Boiler Drums
Can Operators Sit Down Between Rounds?
What's the Best Aircraft Night Warning for a Stack?

Chart Showing Weight of Insulation for Pipes 88

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Thread Cutting in the Lathe

By CARL THOMAS

NO LATHE OPERATION requires more care and study than thread cutting but no phase of lathe operation is more interesting or useful to master.

Depending upon the type of lathe, the setting up of the gear ratios to obtain correct thread cutting lead screw speed will be the first step necessary.

On lathes equipped with standard change gears, a chart is usually attached to the lathe showing the proper gears to be used and their arrangement for each type of thread that the lathe will cut. Generally also included on this chart is information relating to power longitudinal feed (and cross feed where the lathe is so equipped) ratios. Some lathes are equipped to cut Metric threads in addition to English threads, while others can be so adapted by obtaining a set of transposing gears.

Lathes equipped with quick change gears are furnished with a similar chart to be used in setting the gear change levers. This is a much simpler procedure since it is not necessary to remove and install gears.

Some standard change gear lathes are provided with an accessory type semi-quick change device which, by means of lever settings, permits a selection of three to six different gear ratios with each change of standard change gears. One of these arrangements also greatly simplifies the changing of the change gears since no tools are required for the purpose.

By reversing the direction of the lead screw, by means of the lever provided for this purpose, either right or left hand threads may be cut.

With the proper gear ratios set up, the next step is to make sure that the lead screw is rotating in the proper direction for the type thread to be cut. Different arrangements of change gears will alter the direction of rotation of the lead screw. When cutting a right hand thread the carriage must travel toward the headstock. For left hand threading it must travel toward the tailstock.

For the beginner, it is advisable to select the lowest lathe spindle speed for thread cutting.

At this point it is well to become familiar with several terms relating to thread cutting. The major diameter of a thread is the largest diameter of the thread of either a screw or a nut. This is illustrated in Fig. 1, as are the following additional terms.

The minor diameter is the smallest diameter of the thread of either the screw or the nut.

The pitch diameter on a straight screw thread is the diameter of an imaginary cylinder whose surface would pass through the threads at such points as would make the width of the threads and the width of the spaces between the threads equal. In Fig. 1 the line representing one side of the pitch diameter is so located as to make space (a) equal in width to part (b) of the thread. On American National and 60 deg Vee-type threads, the pitch diameter is simply the major diameter less the depth of the thread on one side of the screw or nut.

The depth of thread is one-half the difference between the major and minor diameters. In lathe work, the double depth of thread is quite a common term. This is simply the difference between the major and minor diameters. When the major diameter required is known, subtracting from it the double depth of thread for the required pitch will give the minor diameter. Double depths of American National threads for different pitches are given in Fig. 3.

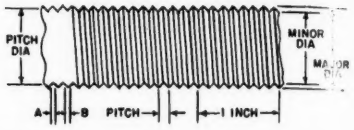


Fig. 1. Diagram defining thread cutting terms

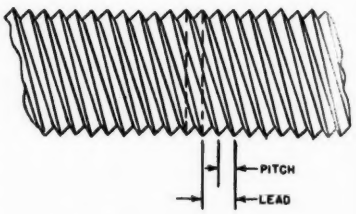


Fig. 2. Double thread screw

The pitch of a thread is the distance between corresponding points on adjacent threads, measured parallel to the axis, as shown in Fig. 1.

Threads per inch is the number of complete threads in the space on one inch. This is shown in Fig. 1.

The lead of a thread is the distance a screw thread advances axially in one revolution. The lead is equal to the pitch on a single thread screw. On a double thread screw the lead is twice the pitch; on a triple thread screw the lead is three times the pitch, etc. This difference between lead and pitch on multiple thread screws is demonstrated in Fig. 2.

There are two general types of thread, external and internal. The thread on a plug is an example of an external thread; while the thread inside a nut is an example of an internal thread.

Of course, under certain conditions, both external and internal threads may be cut on a lathe by the use of dies and taps. Generally the work to be threaded is chucked in the lathe chuck, but it is possible to use a lathe dog and steady rest for threading. In this case it is necessary to use a rawhide thong or leather belt lace to fasten the lathe dog to the face plate. The die or tap is held in a stock or holder and prevented from rotating by the handle resting against a block of wood laid on the lathe bed for protection. The tap may also be held in a drill chuck in the tailstock, if desired. An alternate methed of holding the die consists in using a lathe type die holder in the tailstock of the lathe.

When etxernal and internal threads are to be cut on a lathe by means of lathe threading tools, it is necessary that the cutter bits be formed cor-

Every operator in a power plant should know something about the operation of a lathe. A lathe is an indispensable part of the maintenance equipment of every power plant, large or small, and it is essential that there always be somebody on hand to operate it in time of emergency. The prompt fashioning of a vital part may often mean the difference between quick resumption of service and a costly shutdown. One of the most important functions of a lathe is thread cutting and also it is the most complicated; it requires the greatest amount of study and experience. While many books have been written on lathe operation and while there is an abundance of material available, many operators working in power plants do not necessarily have access to this material and it is for this reason that this article on thread cutting is presented in these pages. It gives complete instructions for cutting threads of various kinds together with tables and diagrams. The subject is too extensive to cover a single issue; this is only the first part, discussing the various types of threads. A second part, describing the actual process of cutting threads will be presented in a subsequent issue

DEPTH AND DOUBLE DEPTH OF AMERICAN NATIONAL THREADS

THREADS PER INCH	(WHEN CUT WITH AMER. NAT'L THREADING TOOL) SINGLE DEPTH OF THREAD	DOUBLE DEPTH OF THREAD	(WHEN CUT WITH 60 DEG. VEE THREADING TOOL) SINGLE DEPTH OF THREAD	DOUBLE DEPTH OF THREAD	DEPTH OF COMPOUND FEED, A. N. TOOL	VEE TOOL
4	.1624	.3248	.1894	.3789	.186	.216
4½	.1443	.2887	.1684	.3368	.165	.195
5	.1299	.2598	.1516	.3031	.148	.173
5½	.1181	.2362	.1378	.2755	.135	.157
6	.1083	.2165	.1263	.2525	.124	.144
7	.0928	.1856	.1082	.2165	.106	.123
8	.0812	.1624	.0947	.1894	.093	.108
9	.0722	.1443	.0842	.1684	.083	.096
10	.0650	.1299	.0758	.1515	.074	.087
11	.0590	.1181	.0689	.1377	.067	.078
12	.0541	.1083	.0631	.1263	.062	.072
13	.0500	.0999	.0585	.1166	.057	.067
14	.0464	.0928	.0541	.1082	.055	.062
16	.0406	.0812	.0473	.0947	.046	.054
18	.0361	.0722	.0421	.0842	.041	.047
20	.0325	.0650	.0379	.0758	.037	.043
22	.0295	.0590	.0345	.0690	.034	.038
24	.0271	.0541	.0316	.0632	.031	.036
27	.0241	.0481	.0281	.0562	.028	.032
28	.0232	.0464	.0270	.0541	.027	.031
30	.0217	.0433	.0255	.0506	.025	.029
32	.0203	.0406	.0237	.0474	.025	.027
36	.0180	.0361	.0211	.0421	.021	.024
40	.0162	.0325	.0189	.0379	.019	.021
44	.0148	.0295	.0172	.0345	.017	.020
48	.0135	.0271	.0157	.0315	.015	.018
50	.0130	.0260	.0151	.0303	.015	.017
56	.0116	.0232	.0135	.0271	.013	.016
64	.0101	.0203	.0118	.0237	.012	.014
72	.0090	.0180	.0105	.0210	.010	.012
80	.0081	.0162	.00945	.0189	.009	.011
96	.0068	.0136	.00901	.01802	.008	.010

NATIONAL COARSE THREAD

NOMINAL SIZE	THREADS PER INCH	MAJOR DIAMETER INCHES	MINOR DIAMETER INCHES	PITCH DIAMETER INCHES	TAP DRILL FOR 75% DEPTH OF THREAD	CLEARANCE DRILL SIZE
1	64	.0730	.0527	.0629	53	47
2	56	.0860	.0628	.0744	50	42
3	48	.0990	.0719	.0855	47	36
4	40	.1120	.0795	.0958	43	31
5(1/8)	40	.1250	.0925	.1088	38	29
6	32	.1380	.0974	.1177	36	25
8	32	.1640	.1234	.1437	29	16
10	24	.1900	.1359	.1629	25	13/64"
12	24	.2160	.1619	.1889	16	7/32"
1/4"	20	.2500	.1850	.2175	7	17/64"
5/16"	18	.3125	.2403	.2764	F	21/64"
3/8"	16	.3750	.2938	.3344	5/16"	25/64"
7/16"	14	.4375	.3447	.3911	U	29/64"
1/2"	13	.5000	.4001	.4500	27/64"	33/64"
9/16"	12	.5625	.4542	.5084	31/64"	37/64"
5/8"	11	.6250	.5069	.5660	17/32"	41/64"
3/4"	10	.7500	.6201	.6850	21/32"	49/64"
7/8"	9	.8750	.7501	.8028	49/64"	57/64"
1"	8	1.0000	.8376	.9188	7/8"	1- 1/64"
1- 1/8"	7	1.1250	.9594	1.0522	63/64"	1- 9/64"
1- 1/4"	7	1.2500	1.0844	1.1672	1- 7/64"	1-17/64"
1- 3/8"	6	1.3750	1.1585	1.2667	1- 7/32"	1-25/64"
1- 1/2"	6	1.5000	1.2835	1.3917	1-11/32"	1-33/64"
1- 3/4"	5	1.7500	1.4902	1.6201	1- 9/16"	1-49/64"
2"	4-1/2	2.0000	1.7113	1.8557	1-25/32"	2- 1/32"
2- 1/4"	4-1/2	2.2500	1.9613	2.1057	2- 1/32"	2- 9/32"
2- 1/2"	4	2.5000	2.1752	2.3376	2- 1/4"	2-17/32"
2- 3/4"	4	2.7500	2.4252	2.5876	2- 1/2"	2-25/32"
3"	4	3.0000	2.6752	2.8376	2- 3/4"	3- 1/32"
3- 1/4"	4	3.2500	2.9252	3.0876	3"	3- 9/32"
3- 1/2"	4	3.5000	3.1752	3.3376	3- 1/4"	3-17/32"
3- 3/4"	4	3.7500	3.4252	3.5876	3- 1/2"	3-25/32"
4"	4	4.0000	3.6752	3.8376	3- 3/4"	4- 1/32"

NATIONAL FINE THREAD

NOMINAL SIZE	THREADS PER INCH	MAJOR DIAMETER INCHES	MINOR DIAMETER INCHES	PITCH DIAMETER INCHES	TAP DRILL FOR 75% DEPTH OF THREAD	CLEARANCE DRILL SIZE
0	80	.0600	.0438	.0519	3/64"	51
1	72	.0730	.0550	.0640	55	47
2	64	.0860	.0657	.0759	50	42
3	56	.0990	.0758	.0874	45	36
4	48	.1120	.0849	.0985	42	31
5(1/8)	44	.1250	.0955	.1102	37	29
6	40	.1380	.1055	.1218	33	25
8	36	.1640	.1279	.1460	29	16
10	32	.1900	.1494	.1697	21	13/64"
12	28	.2160	.1696	.1928	14	7/32"
1/4"	28	.2500	.2036	.2268	3	17/64"
5/16"	24	.3125	.2584	.2854	I	21/64"
3/8"	24	.3750	.3209	.3479	Q	25/64"
7/16"	20	.4375	.3726	.4050	25/64"	29/64"
1/2"	20	.5000	.4351	.4675	29/64"	33/64"
9/16"	18	.5625	.4903	.5264	33/64"	37/64"
5/8"	18	.6250	.5528	.5889	37/64"	41/64"
3/4"	16	.7500	.6688	.7094	11/16"	49/64"
7/8"	14	.8750	.7822	.8286	13/16"	57/64"
1"	14	1.0000	.9072	.9536	15/16"	1- 1/64"
1- 1/8"	12	1.1250	1.0168	1.0709	1- 3/64"	1- 9/64"
1- 1/4"	12	1.2500	1.1418	1.1959	1-11/64"	1-17/64"
1- 3/8"	12	1.3750	1.2668	1.3209	1-19/64"	1-25/64"
1- 1/2"	12	1.5000	1.3918	1.4459	1-27/64"	1-33/64"

NATIONAL SPECIAL THREAD

NOMINAL SIZE	THREADS PER INCH	MAJOR DIAMETER INCHES	MINOR DIAMETER INCHES	PITCH DIAMETER INCHES	TAP DRILL FOR 75% DEPTH OF THREAD	CLEARANCE DRILL SIZE
1/16"	64	.0625	.0422	.0524	3/64"	51
5/64"	60	.0781	.0565	.0673	1/16"	45
3/32"	48	.0958	.0667	.0805	49	40
7/64"	48	.1094	.0823	.0959	43	32
1/8"	32	.1250	.0844	.1047	3/32"	29
9/64"	40	.1406	.1081	.1244	32	24
5/32"	32	.1563	.1157	.1360	1/8"	19
5/32"	36	.1563	.1202	.1382	30	19
11/64"	32	.1719	.1313	.1516	9/64"	14
3/16"	24	.1875	.1334	.1604	26	8
3/16"	32	.1875	.1469	.1672	22	8
13/64"	24	.2031	.1490	.1760	20	3
7/32"	24	.2188	.1646	.1917	16	1
7/32"	32	.2188	.1782	.1985	12	1
15/64"	24	.2344	.1806	.2075	10	1/4"
1/4"	24	.2500	.1959	.2229	A	17/64"
1/4"	27	.2500	.2019	.2260	B	17/64"
1/4"	32	.2500	.2094	.2297	7/32"	17/64"
5/16"	20	.3125	.2476	.2800	17/64"	21/64"
5/16"	27	.3125	.2644	.2884	J	21/64"
5/16"	32	.3125	.2719	.2922	9/32"	21/64"
3/8"	20	.3750	.3100	.3425	21/64"	25/64"
3/8"	27	.3750	.3269	.3509	R	25/64"
7/16"	24	.4375	.3834	.4104	X	29/64"
7/16"	27	.4375	.3894	.4134	Y	29/64"
1/2"	12	.5000	.3918	.4459	27/64"	33/64"
1/2"	24	.5000	.4459	.4729	29/64"	33/64"
1/2"	27	.5000	.4519	.4759	15/32"	33/64"
9/16"	27	.5625	.5144	.5384	17/32"	37/64"
5/8"	12	.6250	.5168	.5709	33/64"	41/64"
5/8"	27	.6250	.5769	.6009	19/32"	41/64"
11/16"	11	.6875	.5694	.6285	19/32"	45/64"
11/16"	16	.6875	.6065	.6469	5/8"	45/64"
3/4"	12	.7500	.6418	.6959	43/64"	49/64"
3/4"	27	.7500	.7019	.7259	23/32"	49/64"
13/16"	10	.8125	.6826	.7476	23/32"	53/64"
7/8"	12	.8750	.7668	.8209	51/64"	57/64"
7/8"	18	.8750	.8028	.8389	53/64"	57/64"
7/8"	27	.8750	.8269	.8509	27/32"	57/64"
15/16"	9	.9375	.7932	.8684	55/64"	61/64"
1"	12	1.0000	.8918	.9459	59/64"	1- 1/64"
1"	27	1.0000	.9519	.9759	31/32"	1- 1/64"
1- 5/8"	5-1/2	1.6250	1.3888	1.5069	1-29/64"	1-41/64"
1- 7/8"	5	1.8750	1.6152	1.7451	1-11/16"	1-57/64"
2- 1/8"	4-1/2	2.1250	1.8368	1.9807	1-29/32"	2- 5/32"
2- 3/8"	4	2.3750	2.0502	2.2126	2- 1/8"	2-13/32"

Fig. 3 (Upper left) Depth and double depth of American Pipe threads. Fig. 4. (Upper right) National Coarse Thread. Fig. 5. (Lower left) National Fine Thread. (Fig. 6. (Lower right) National Special Thread

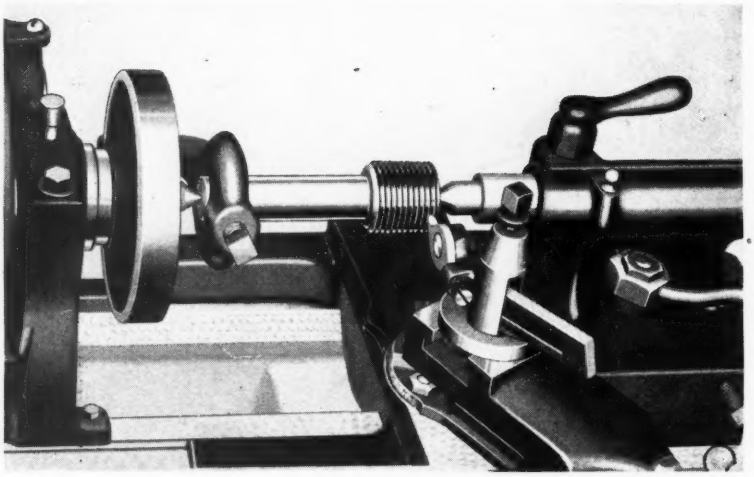


Fig. 7. This formed threading tool comes furnished with a tool holder. It is designed so that it can be resharpened by simply grinding on the top surface of the cutter; thus the point always retains its true form and correct angle

rectly to cut an accurate thread. For cutting external standard Vee-type 60 deg threads the simplest and best type tool is a formed thread cutting tool. This comes furnished with a tool holder to fit the lathe tool post. It is so designed that it can be resharpened simply by grinding on the top surface of the cutter only. Thus the cutter point always retains its true form and correct angle. An adjustment is provided to compensate for metal removed from the cutter point by grinding. Fig. 7 shows a tool of this type in use.

Regular cutter bits, when used for external threading, must be carefully ground and set if an accurate thread form is to be obtained. A gage should be used for grinding the lathe tool to the shape required by the form of thread to be cut.

At this point it is well to explain the various types of threads in use. In 1928 the National Screw Thread Commission was authorized by Con-

SQUARE THREAD

THREADS PER INCH	PITCH INCHES P	DEPTH OF THREAD	DOUBLE DEPTH OF THREAD	WIDTH OF TOP OF THREAD	WIDTH OF SPACE AT BOTTOM OF THREAD
1	1.0000	.5000	1.0000	.5000	.5000
1-1/3	.7500	.3750	.7500	.3750	.3750
1-1/2	.6667	.3333	.6667	.3333	.3333
1-3/4	.5714	.2857	.5714	.2857	.2857
2	.5000	.2500	.5000	.2500	.2500
2-1/2	.4000	.2000	.4000	.2000	.2000
3	.3333	.1667	.3333	.1667	.1667
3-1/2	.2857	.1429	.2857	.1429	.1429
4	.2500	.1250	.2500	.1250	.1250
4-1/2	.2222	.1111	.2222	.1111	.1111
5	.2000	.1000	.2000	.1000	.1000
5-1/2	.1818	.0909	.1818	.0909	.0909
6	.1667	.0833	.1667	.0833	.0833
7	.1429	.0714	.1429	.0714	.0714
8	.1250	.0625	.1250	.0625	.0625
9	.1111	.0556	.1111	.0556	.0556
10	.1000	.0500	.1000	.0500	.0500
11	.0909	.0455	.0909	.0455	.0455
12	.0833	.0417	.0833	.0417	.0417
13	.0769	.0385	.0769	.0385	.0385
14	.0714	.0357	.0714	.0357	.0357
15	.0667	.0333	.0667	.0333	.0333
16	.0625	.0312	.0625	.0312	.0312
18	.0556	.0278	.0556	.0278	.0278
20	.0500	.0250	.0500	.0250	.0250
22	.0455	.0227	.0455	.0227	.0227
24	.0417	.0208	.0417	.0208	.0208

ACME STANDARD THREAD

THREADS PER INCH	PITCH INCHES P	DEPTH OF THREAD	DOUBLE DEPTH OF THREAD	WIDTH OF TOP OF THREAD	WIDTH OF SPACE AT BOTTOM OF THREAD
1	1	.5100	1.0200	.3707	.3655
1-1/3	3/4	.3850	.7700	.2780	.2728
2	1/2	.2600	.5200	.1855	.1801
3	1/3	.1767	.3534	.1235	.1183
4	1/4	.1350	.2700	.0927	.0875
5	1/5	.1100	.2200	.0741	.0689
6	1/6	.0933	.1867	.0618	.0566
7	1/7	.0814	.1628	.0530	.0478
8	1/8	.0725	.1450	.0463	.0411
9	1/9	.0655	.1311	.0413	.0361
10	1/10	.0600	.1200	.0371	.0319

STOVE BOLT (60 DEGREE) THREAD

NOMINAL SIZE	THREADS PER INCH	MAJOR DIAMETER INCHES	MINOR DIAMETER INCHES	PITCH DIAMETER INCHES	TAP DRILL SIZE	CLEARANCE DRILL SIZE
1/8"	32	.1250	.0910	.1080	42	29
5/32"	28	.1630	.1250	.1440	1/8"	19
3/16"	24	.1950	.1510	.1730	24	8
7/32"	22	.2220	.1740	.1980	16	1
1/4"	18	.2500	.1980	.2240	8	17/64"
5/16"	18	.3125	.2405	.2764	C	21/64"
3/8"	16	.3750	.2958	.3344	M	25/64"
7/16"	14	.4375	.3447	.3911	S	29/64"
1/2"	13	.5000	.4000	.4500	Y	33/64"

NATIONAL SPECIAL (MACHINE SCREW) THREAD

NOMINAL SIZE	THREADS PER INCH	MAJOR DIAMETER INCHES	MINOR DIAMETER INCHES	PITCH DIAMETER INCHES	TAP DRILL FOR 75% DEPTH OF THREAD	CLEARANCE DRILL SIZE
1	56	.0730	.0498	.0614	54	47
4	32	.1120	.0714	.0917	45	31
4	36	.1120	.0759	.0940	44	31
5(1/8)	36	.1250	.0889	.1070	40	29
6	36	.1380	.1019	.1200	34	25
7	30	.1510	.1077	.1294	31	21
7	36	.1510	.1149	.1330	1/8"	21
8	30	.1640	.1207	.1423	30	16
8	40	.1640	.1315	.1478	28	16
9	24	.1770	.1229	.1499	29	13
9	30	.1770	.1337	.1555	27	13
9	32	.1770	.1364	.1567	26	13
10	28	.1900	.1456	.1668	25	13/64"
10	30	.1900	.1467	.1684	22	13/64"
12	32	.2160	.1754	.1957	15	7/32"
14	20	.2420	.1770	.2095	10	17/64"
14	24	.2420	.1879	.2149	7	17/64"

Fig. 8. (Upper left) Square Thread. Fig. 9. (Upper right) Acme Standard Thread. Fig. 10. (Lower left) Stove Bolt (60 deg) Thread. Fig. 11. (Lower right) National Special (Machine Screw) Thread

gress to establish a standard system of screw threads for use in the United States. This commission established the American National Screw Thread System, which has been approved by Congress, the War Department and the Navy Department. It is now generally used by all shops in this country, being practically standard for automotive and machine shop work.

These threads comprise those most likely to be cut in the lathe. However, there are several other types of threads that are cut occasionally and it is well to have a knowledge of them. These include Acme screw thread, which is often used where heavy loads require close-fitting threads. Typical applications of Acme threads are the lead screw, cross feed screw and compound rest feed screw of most lathes. Fig. 9 gives the dimensions for these threads.

Another type thread is called square thread. This thread is used to a considerable extent in vises, clamp screws and similar applications. Fig. 8 gives the dimensions for square thread. Square thread is difficult to cut and is not as strong as Acme thread. For this reason Acme thread is recommended for all such applications. It is stronger, easier to cut, and capable of closer fits.

Occasionally it may be necessary to cut pipe threads in the lathe. These threads are 60 deg Vee-type and are cut in two styles. The straight form pipe thread is similar to bolt thread and is used on oil cups, electrical fittings, etc. The tapered form is cut on a taper of ¾ in. per foot and is so designed that it jams when screwed into threaded fittings and thus forms a tight joint. Fig. 13 gives pipe thread dimensions. Since these dimensions refer only to straight pipe threads, when cutting tapered threads it should be remembered that the same

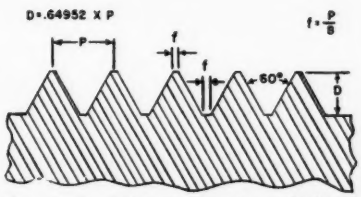
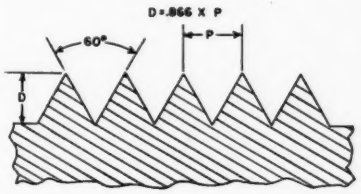


Fig. 11-A. (Above) American National Thread Formula. Fig. 12. (Below) 60 deg Vee-type Thread Formula



dimensions apply, being the dimensions of the first thread at the beginning of the cut. The taper feed of the cutting tool in relation to the work will produce the proper taper for succeeding threads.

Since sometimes it is desirable to match foreign threads, such as may be found on cameras, optical instruments, scientific instruments, etc., it is well to have access to tables of these and the International Standard Metric screw threads.

While it is seldom, if ever, that one is likely to wish to produce stove bolt threads, since these bolts are almost always used with their own threaded square type nuts, a table of threaded dimensions is given in Fig. 12 for use if needed.

For craftsmen who build working mechanical models and apparatus, the occasion may arise where it is desired to cut a duplicate worm. Since worms are cut in a manner similar to threads, a simple formula will be given later for determining the depth of thread and the width of teeth tops and bottoms.

Referring to the sketch in Fig. 11-A, it may be observed that American National threads are similar to 60 deg Vee-type threads, shown in Fig. 13, except that the tops and bottoms of the threads are flat. The 60 deg Vee-type thread is seldom cut, except for small screws and nuts where the flat at the top and bottom of American National threads would be so small as to approach the Vee form. Usually small taps are designed to produce Vee-type threads, the resulting threads accommodating American National threaded screws. American National threads have a depth of ¾ that of 60 deg Vee threads of the same pitch.

In cutting 60 deg Vee threads and American National threads with a regular lathe tool, the bit is ground as shown in Fig 14. For American National threads the point should be ground flat to fit the proper opening in a thread gage for this type of thread. A 60 deg center gage may be used for checking the 60 deg angle of such threading tools. Sometimes the cutter bit is left sharp on the point even when cutting American National threads. The thread is thus cut with a Vee bottom, but the top is left with the proper amount of flat. If absolute maximum strength is desired, the tool should be ground to the exact form of the American National thread as already explained.

It may be noted in Fig. 14 that the front clearance is 8 degrees. It is necessary that sufficient front clearance be given the cutter bit to permit it to cut freely. If the material being cut is such as to permit greater front clearance without weakening the cutting edge, this will usually prevent

AMERICAN STANDARD PIPE THREAD

(STRAIGHT THREAD)

NOMINAL PIPE SIZE	THREADS PER INCH	MAJOR DIAMETER INCHES	MINOR DIAMETER INCHES	PITCH DIAMETER INCHES	TAP DRILL FOR FULL THREAD
1/8"	27	.4044	.3451	.3748	11/32"
1/4"	18	.5343	.4455	.4899	7/16"
3/8"	18	.6714	.5826	.6270	37/64"
1/2"	14	.8356	.7213	.7784	23/32"
3/4"	14	1.0460	.9318	.9889	59/64"
1"	11-1/2	1.3082	1.1690	1.2386	1- 5/32"
1-1/4"	11-1/2	1.6630	1.5138	1.5834	1- 1/2"
1-1/2"	11-1/2	1.8919	1.7527	1.8223	1-47/64"
2"	11-1/2	2.3658	2.2267	2.2963	2- 7/32"
2-1/2"	8	2.8622	2.6622	2.7622	2- 5/8"
3"	8	3.4885	3.2885	3.3885	3- 1/4"
3-1/2"	8	3.9888	3.7888	3.8888	3- 3/4"
4"	8	4.4871	4.2871	4.3871	4- 1/4"

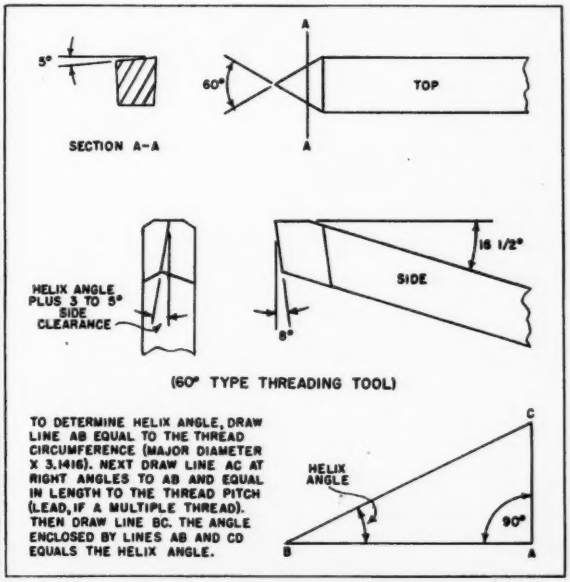

5°
SECTION A-A
A
60°
TOP
A
HELIX ANGLE PLUS 3 TO 5° SIDE CLEARANCE
16 1/2°
SIDE
8°
(60° TYPE THREADING TOOL)
TO DETERMINE HELIX ANGLE, DRAW LINE AB EQUAL TO THE THREAD CIRCUMFERENCE (MAJOR DIAMETER X 3.1416). NEXT DRAW LINE AC AT RIGHT ANGLES TO AB AND EQUAL IN LENGTH TO THE THREAD PITCH (LEAD, IF A MULTIPLE THREAD). THEN DRAW LINE BC. THE ANGLE ENCLOSED BY LINES AB AND CD EQUALS THE HELIX ANGLE.
C
HELIX ANGLE
90°
B
A

Fig. 13. (Left) American Standard Pipe Thread. Fig. 14. (Right) Diagram explaining threading tool definitions

the tool from dragging in the helix angle of the thread and thus make unnecessary the calculation of the tool's helix clearing angle. On very coarse pitches, however, the helix clearance angle of the cutter bit must be calculated.

Where a formed threading tool is used there is ample clearance provided for even the coarsest threads. The sides of this tool are ground to an included angle of approximately 65 deg when it is manufactured. The extra 5 deg compensates for rake angle and the grinding of the tool. When the tool is set into the work at the proper angle a perfect 60 deg thread is produced.

A screw pitch gage with separate leaves for each pitch of thread is very convenient when checking the pitch of a Vee thread screw or nut.

Note: This is the first of three articles on this subject by the author. A second article dealing with the actual process of thread cutting will appear in the next issue.

Blower Types Classified by Specific Speed

By A. M. G. MOODY, *Chief Blower Engineer, Elliott Co.*

THE CONCEPT of specific speed is very useful in classifying different types of compressors, and thus arriving at a clear picture of the applications for which they are best suited.

It is characteristic of a centrifugal machine that the pressure developed in a given wheel running at a given speed is proportional to the density of the fluid handled.

In the case of air or gas (compressible fluids), the problem is not as simple as it is with non-compressible liquids. The trouble is that as we compress the gas, its density changes, and it changes by different amounts with different gases.

For low pressure rise, divide the actual pressure rise by the density. We could, then, find the pressure which the particular blower would develop when handling air by simply dividing the pressure rise by the ratio of the density of the gas to that of air under standard conditions.

This process is useful only when the density of the gas does not change much during compression, that is, for a small pressure rise. For higher pressures, we must resort to the use of the standard formula for adiabatic compression.

The formulas is as follows:

$$Head = \frac{K}{K-1} \quad \frac{1545.4}{MW} \; X \; T_1$$

where:

K is the ratio of specific heat at constant pressure to specific heat at constant volume for the gas in question.

MW is the molecular weight of the gas.

T_1 is the inlet temperature in degrees F.

X is a compression factor given by the following expression:

$$X = \left(\frac{P_1}{P_2}\right)^{\frac{K-1}{K}} - 1$$

where P_1 and P_2 are, respectively, the absolute inlet and discharge pressures.

For gases having the same value of K, the head will obviously vary inversely as the molecular weight, or if we set up air as a standard, the specific gravity. Then, to find the equivalent air pressure, we find the X factor for the gas, divide by the specific gravity, and find the pressure ratio in air which will give this value. This calculation, while it is quite simple, is not conveniently done without a log log slide rule. Fortunately, however, Tables for X are available (ASME Power Test Code No. 10, Centrifugal Compressors, Exhausters, and Fans, 1935).

The importance of inlet temperature must not be overlooked. The higher it is, the less dense the gas, and the greater the Equivalent Air Pressure for a given pressure ratio.

It also must be remembered that some gases have values of K very different from that of air. Among these gases are the hydrocarbons and the halogenated hydrocarbons used in refrigeration.

Table I gives the approximated specific gravities of a number of gases frequently encountered.

Table I

Gas	Specific Gravity
Air	1.00
Coke Oven Gas	0.35
Blast Furnace Gas	1.00
Water Gas	0.65
Kiln Gas	1.15

Specific Speed

The specific speed is an abstract concept which indicates the speed at which a given machine would have to run in order to handle a standard amount of a fluid with a standard amount of head, if it were shrunk uniformly in all its dimensions. What it shows is whether a machine is inherently a high-speed or low-speed device. Knowing this and the conditions required in a given application, we can determine what specific speed is required.

The efficiency of a given type of machine varies with specific speed, there being an optimum value. If the specific need is too far from this value, it becomes impractical to build a machine of this type.

The formula for specific speed is

$$N_s = \frac{C \, n \sqrt{Q}}{H^{\frac{3}{4}}}$$

where

C is a constant

n is the actual speed of the machine in rpm

Q is the inlet capacity in cfm

H is the adiabatic head in feet

In order to make it easy to determine the specific speed, the formula will now be rewritten as follows:

$$N_s = F \quad \frac{n}{1000} \quad \sqrt{\frac{Q}{1000}}$$

where F is a factor depending on the EAP.—See Fig. 1.

In using this expression, the speed in rpm is divided by 1000 and the flow in cfm is also divided by 1000. Then the product of $\frac{n}{1000}$ by the square root of $\frac{Q}{1000}$ by the factor F gives specified speed.

Range of Machines

Figure 2 shows the approximate range of specific speeds covered by each of a number of types of compressors. Naturally there is some overlapping. A general idea of the relation of these machines to each other might be stated thus: low specific speed means low inlet volume, low speed, high pressure; high specific speed means large volume, high speed, low pressure.

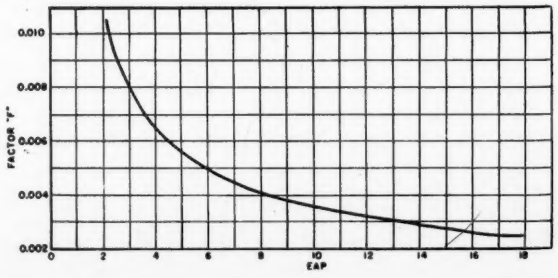


Fig. 1. Curve showing the relationship between equivalent air pressure and specific speed factor "F"

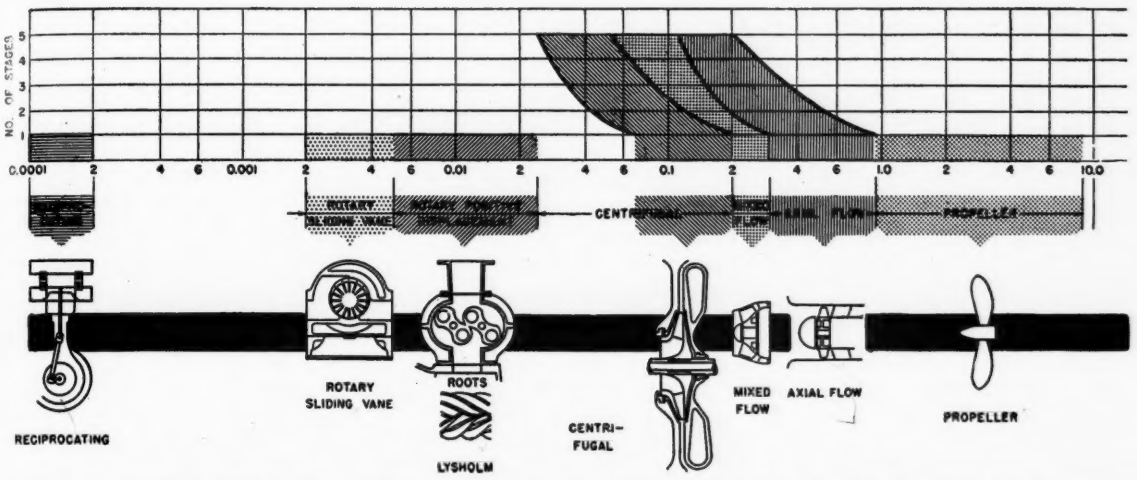


Fig. 2. The approximate range of specific speeds covered by each of a number of types of compressors. The effect of multi-stagging, shown only for centrifugal and axial-flow machines, is that of producing lower effective specific speeds

For a given type of machine, best performance is obtained near the middle of the range. At either the high or low limit shown, for centrifugals, the efficiency is well below the best possible values.

Example

To illustrate the use of this concept, suppose we want to compress 20,000 cfm of air to a pressure of 5 psig with standard inlet conditions. The factor F for 5 lb EAP is 0.0057. The specific speed is then

$$N_s = 0.0057 \frac{n}{1000} \sqrt{20} = 0.0255 \frac{n}{1000}$$

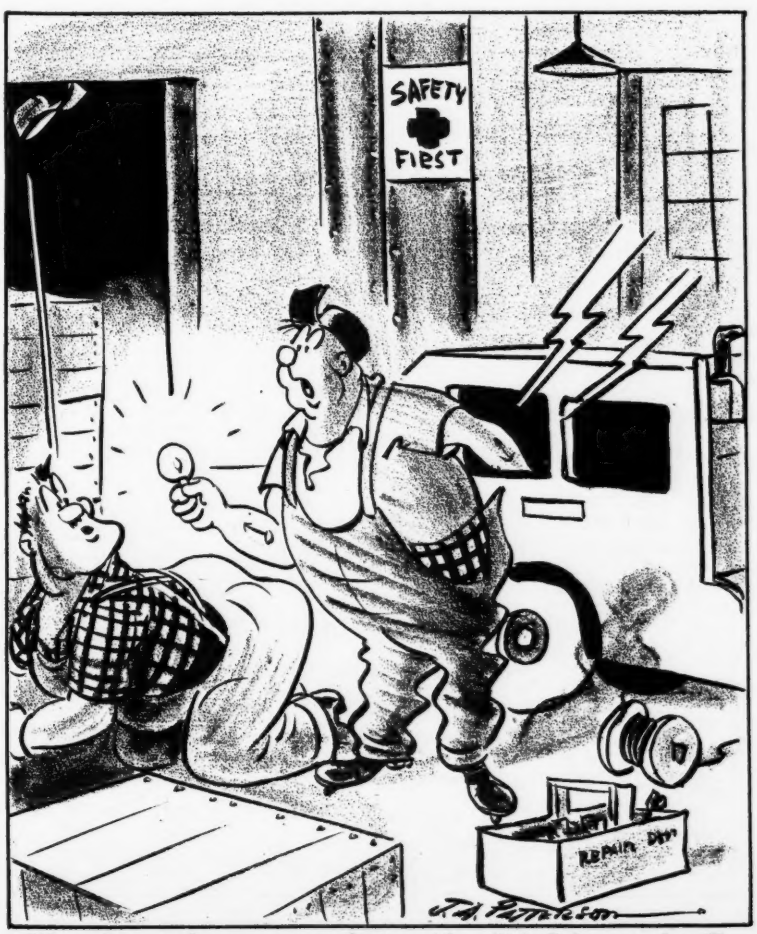
From this we see that for a direct motor drive at 3550 rpm, we will have $N_s = 0.091$. This can be done with a centrifugal blower, but is a little below the best point. A turbine drive at 5000 rpm would give us the better value of 0.128.

Suppose, on the other hand, that we were to handle only 2000 cfm at 5 lb EAP. We see that even to reach the lower limit of specific speed for a centrifugal blower, we would have to run at 9000 rpm. For the most favorable speed, the machine should operate at 15,000 rpm, but limitations in respect to available drivers would normally dictate a compromise at a lower specific speed.

For 3600 rpm, the specific speed is 0.029, which puts it in the Lysholm or Roots field.

Multi-Staging

So far no mention has been made of multi-staging. The primary purpose of multi-staging is to permit reaching higher pressures without employing unduly high tip speeds. Multi-staging, however, has a secondary effect, illustrated in the diagram, Fig. 2, of giving lower effective specific speeds, with the result that there is some definite overlapping of the fields of application of centrifugal and positive displacement machines. The effect of multi-staging is shown only for centrifugal and axial-flow machines, though obviously it applies to any type. Furthermore, by paralleling compressors, the effective range can be extended in the direction of larger capacity.



"Here, Gus, maybe you can see better with a little light over there!"

Diesel Plant Layout with Auxiliary Equipment

Air filters and silencers . . . Storage and filtering of fuel . . . Starting methods, air, electric, auxiliary engine, gasoline . . . Heat recovering boiler and heat exchanger

In this concluding article of this series, we present a brief discussion of Diesel power plant layouts, Diesel engine starting, and Diesel maintenance. As emphasized in the first article of the series, it is not our intention to present a comprehensive discussion of these subjects, but instead to portray briefly certain aspects of Diesel engine power plants.

Plant Layout

Figure 1 shows a typical Diesel power plant layout in diagrammatic form. Features shown in it will usually appear in every Diesel plant, although perhaps not on the same form nor in an identical layout.

Intake air filters and exhaust silencers are used almost without exception in all stationary Diesel installations. The intake air filter performs the important function of removing dust and dirt from the inlet air and thus helps to keep the cylinders free from contamination. Several different types of this device are available, but the net results are essentially the same from all types.

Exhaust silencers or mufflers work on the same principle as the mufflers used on automobiles, and reduce the objectionable exhaust noise to a reasonable level.

Jacket water in this particular layout is cooled by using a cooling tower, although a spray pond or a number of other methods of cooling the jacket water could be used. Some heat recovery method will be discussed later in this article.

Fuel oil for daily use is pumped from the outside storage tank to day tanks, permitting the oil to settle further, facilitating measurement of the fuel consumed, and maintaining a head on the fuel pump. The fuel oil filter shown can be any of several types, all, performing the function of screening out foreign matter in the fuel.

The lubricating system shown is of the continuous flow type with a bypass filtration system, allowing a portion of the oil to be cleaned while the engine is in operation. An oil cooler is shown to reduce the temperature of the oil and keep it within a safe operating range.

Several different methods of starting Diesels are in use, with many modifications of each method, and the actual starting system used is determined by the size of the engine and the purpose for which it is to be used.

Basic types of starting can be listed as follows:

1. Compressed air starting; a. Admission of compressed air to the starting valves in the engine cylinders, and b. The use of an air motor engaging the engine flywheel through a clutch and Bendix drive.

2. Electric Starting; a. By the use of starting motor and battery, or b. Motorizing the generator.

3. Auxiliary gasoline engine starting, driving the Diesel flywheel through a clutch and a Bendix drive.

4. Starting the Diesel as an Otto engine, using a lower compression ratio, carburetor, and spark ignition system so that gasoline may be used as a fuel.

5. Hand starting—Small engines only.

To facilitate starting a number of various starting aids may be used. including the use of glow plugs to heat the combustion chamber, compression release to facilitate getting the engine up to starting speed before normal compression is returned to the engine, and compression increase to raise the temperatures above normal so that starting is more readily accomplished.

Each manufacturer has his own design of starting system, and to endeavor to describe each type encountered would be futile and misleading. If the engine is in good mechanical condition, if there is sufficient air pressure, and if the fuel injection system functions immediately, any engine can be started in two or three revolutions of the flywheel.

Maintenance schedules will vary

Fig. 2. Diesel engines in municipally owned power plant at Carthage, Mo. Shown in the foreground is a new 3200 hp engine. (Courtesy, Nordberg Mfg. Co.)

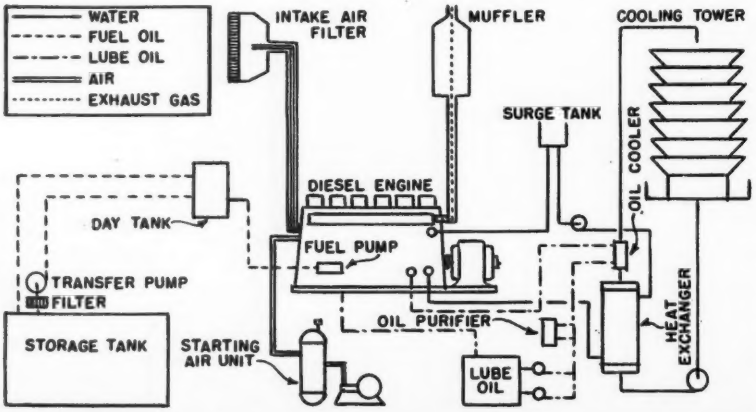


Fig. 1. Diagram of the layout of a Diesel generating plant showing the connection of the various components

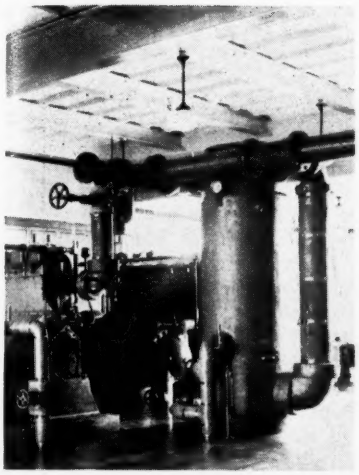


Fig. 3. Waste heat boiler connected to utilize the exhaust gas heat for steam to heat the building

from plant to plant, depending on operating conditions, engine manufacture, size, type, load and plant layout. As a result, to attempt to present a representative inspection and maintenance schedule is to invite criticism and argument.

Many methods of reclaiming waste heat from the exhaust gases and jacket water have been developed, the method depending to a large extent on the installation and requirements of the particular plant. The heat may be used for space heating, for providing hot water or steam for industrial processes, or to provide hot water for sanitary use.•

Scaling of the cooling water jacket is an ever-present problem, and the addition of raw water to the cooling system must be carefully controlled. To eliminate using the water direct from the engine and necessitating the addition of large quantities of raw water, a double circuit type of heat transfer system is used.

Exhaust gas water-tube boilers may be used to generate steam for various uses, and exhaust gases direct from the engine have been used in gas turbines, although this work is at present confined largely to the experimental stage and has not found widespread use.

These various methods of heat recovery result in a very high overall efficiency (based on the energy content of the fuel) when the process demands for steam or hot water coincide well with the engine output.

Diesel engine generating units are being used more extensively today than ever before, in industrial plants, in municipal power plants, and in REA cooperatives. That Diesels can be effectively used in steam plants as part of the base load equipment, not merely as stand by or peak load equipment has been pointed out by A. C. Kirkwood in his article *How a Diesel Fits in a Steam Plant*, which appeared in PPE for October, 1946.

With the ever increasing use of Diesel engines in power plants, the power engineer will be expected to know more and more about this type of prime mover as time goes by.

Bibliography

Diesel Operation, Technical Publishing Co.

Industrial Diesel Engines, Standard Oil Co. (Indiana)

Applied Energy Conversion, by B. G. A. Skrotzki and W. A. Vopat, McGraw-Hill Book Co.

Diesel Engine Starting Methods, *"Diesel Power and Diesel Transportation,"* Feb., 1943, pp. 125-130.

Diesel and Gas Engine Power Plants, by Glenn C. Boyer, McGraw-Hill Book Co., Inc.

Power Plant Engineering and Design, by Frederick T. Morse, D. Van Norstrand Co., Inc.

(Ed. Note: This is the last of four articles on Diesel engines and their care.)

Ten Commandments for Diesel Maintenance

1. Thou shalt keep thine engine clean and in adjustment, that thy life in its company shall be long and that the owner shall increase thy pay.
2. Know thine engine and all its parts and functions, else thou shalt be in some unholy spot.
3. Be not wise in thine own conceit. Remember the factory instructions and keep them holy, lest repairs be thine undoing.
4. Be not loose in thy jaw hinges, for no man knoweth all about Diesels. The truly wise man absorbeth much knowledge and exudeth little; and he who so doeth shall gain repute among his fellows and favors among his superiors.
5. For all things in this life that thou desirest, thou shalt also pay plenty, and for the wisdom of experience, no less. Advice from the multitudes costeth nothing and is usually worth just that.
6. In the books thou mayest read what to do and when; but only the voice of experience may tell thee why and how, else thy reading of what and when shall but plague thee with smoke.
7. God maketh the earth to rotate endlessly without bearings or oil—but not thy Diesel.
8. Curse not thine engine when it turneth not. Curse rather thine own stupidity.
9. Steam engines and gas engines may long turn over though sloppy; a Diesel not so. With gages and mikes be thou ever busy.
10. The Eternal Eye watcheth universal operations, but thou shalt not rely upon it as to thy Diesel. Thine own vigilance is the price thou payest for thy job.

*From "Is Fuel a Major Factor in the Smokeless Operation of a Locomotive or a Stationary Diesel," by R. J. Bender. Assistant to the President (on duty in Addis Ababa, Ethiopia). Sinclair Refining Co., N. Y. Presented before 19th Annual Oil and Gas Power Div., ASME., Cleveland, Ohio, May, 1947.

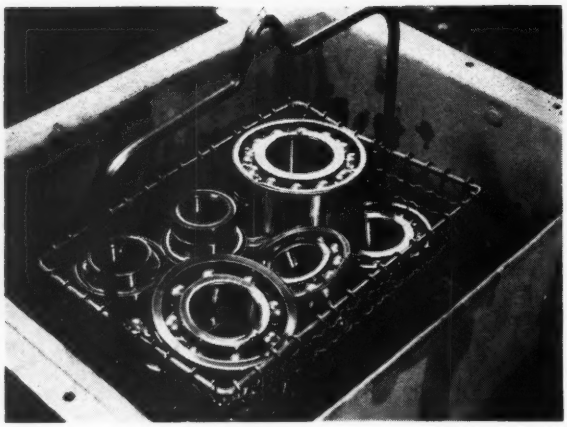


Fig. 1. A wire basket, if available, is better than a pail. Preferably, put in only one layer of bearings and keep the basket off the bottom of the tank

The very appearance of a dirty, used ball bearing that has been removed for inspection or during overhaul, invites careless handling. This same bearing can be as efficient as the day it was installed, and should be handled as carefully. Adequate cleaning may be a simple and quick operation or may require lengthy soaking and the use of several solvents. Proper cleaning may mean the difference between a well-kept ball bearing and one with a short, useless life. Practical tips on simple methods of cleaning ball bearings

Cleaning Used Ball Bearings

By HUDSON T. MORTON
Standards Engineer, The Fafnir Bearing Company

SHINING NEW, a ball bearing fresh from its original packing box generally is treated with the respect, care and cleanliness it demands. When that same bearing has become dirty and unattractive from use, however, and is removed for inspection or during overhaul, its very appearance invites careless handling —yet it may be as efficient as the day it was installed, and should be handled as carefully as on that day.

Adequate cleaning of such a bearing may be simple and quick, or may require lengthy hot soaking and the use of several solvents. Hints on simple cleaning methods only, intended for the man with no large accumulations of dirty, used bearings will be given here.

Before a bearing is exposed, its housing should be cleaned of dirt. Once unmounted, the bearing should be placed in a container of clean solvent—kerosene, low-test gasoline or some other petroleum solvent, with kerosene preferred. (Tetrachloride may be used, but only if it is fresh, if the bearings are handled quickly, free from moisture, and upon being taken out are placed at once in light oil.) It may be necessary to soak a dirty bearing in the solvent for a few minutes or for many hours, depending on its condition. A short-bristled brush will help to loosen the grease, chips and dirt.

Up to this point, that natural tendency to spin the bearing must be resisted. It may be rotated slowly by hand in the solvent, but never spun while dirty, for such action carries dirt into the races. After the initial cleaning, rinsing should be done in another container of clean solvent, preferably a petroleum product such as kerosene. If clean, dry compressed air is available, the remaining dirt should be blown out of the bearing. Do not spin.

Cleaned bearings may be inspected by revolving them slowly to see, hear or feel any defect or dirt. Do not leave them around unprotected, but relubricate, cover or wrap them. Always clean the shaft and housing before re-installing a bearing. The ideal lubricant for a ball bearing is a pure, neutral mineral oil or grease; the preferred type of grease is the soda-soap, except for wet locations; the preferred density is about that of vaseline at 60 F.

Handling ball bearings with the bare hands may leave corrosive perspiration; furthermore, cleaning solvent may harm the skin. Rubber gloves are suggested, or clean rags, tongs, hooks or metal baskets, if there are many bearings to be cleaned.

So, in summary, to conserve the full amount of remaining life-use in an unmounted, dirty, used ball bearing: do not spin it while dirty; soak and wash it in a solvent, preferably kerosene; rinse in more of the same; remove all moisture, bathe in light oil or relubricate; protect until reused.

Fig. 2. Soak dirty bearings in plenty of solvent to loosen dirt and grease

Fig. 3. Rinse bearings in a clean solvent. Kerosene or a low-test gasoline

Fig. 4. Don't spin a dirty bearing. Dirt can cause serious scratching

Fig. 1. **Sectional view of a typical micrometer. (Photo courtesy Browne and Sharpe Mfg. Co.)**

How to Read Micrometers and Verniers

Some mechanics shun the use of micrometers because of a belief that these instruments are difficult to read. This is not true, and they thus deprive themselves of the numerous conveniences a micrometer affords for checking and measuring machine parts, tools, or materials

By JOHN FOSTER

THE PROTOTYPE of the modern micrometer was patented by Palmer in France in 1848. In 1867 Brown and Sharpe adopted a system of graduations similar to that of the Palmer tool, added a means of compensating for wear, and introduced the first practical micrometer. Since then a number of improvements have been made in micrometer design, and today over four hundred different micrometer calipers are made to meet various shop requirements.

Principle of Operation

By referring to the sectional view of a typical micrometer shown in Fig. 1, the principle of operation of this type of tool will be more easily understood. The object to be measured is placed between the surface of the anvil and the end of the adjustable spindle. The spindle is threaded inside the micrometer so that by rotating it it can be made to lightly clamp the object being measured. The knurled thimble affords a convenient means of rotating the spindle since it is attached directly to it. On some models, a ratchet knob is provided to limit the clamping force that can be applied to the spindle in order to prevent distortion of the frame of the instrument. A lock nut is also usually provided to clamp the spindle when transferring measurements.

Adjustments are provided on most micrometers to compensate for wear of the parts. An adjusting nut on the spindle nut permits the tension on the spindle screw to be regulated. To permit readjustment to be made whenever necessary to re-align the zero setting, various means are provided. On one popular make the graduated sleeve is turned with a special spanner wrench until it lines up accurately with the zero graduation on the thimble. With another popular make the method is different. A cap that locks the thimble to the spindle is loosened with a small spanner wrench and the thimble zero graduation aligned with the longitudinal graduation line on the barrel of the instrument. Then the locking cap is again tightened.

The English Type Micrometer

In order to understand the reading of a micrometer it should be remembered that, in the English measuring type, the pitch of the spindle screw is 1/40 inch or 40 threads per inch. This means that one exactly complete revolution of the micrometer spindle screw moves the contact face of the spindle away from or towards the face of the anvil 1/40 in. or 25 thousandths (0.025) inch.

The graduation lines on the sleeve or barrel, Fig. 2, of the micrometer conform to the pitch of the spindle screw, each line thus indicating 0.025 inch. For convenience in reading, each fourth line is numbered 1, 2, 3,

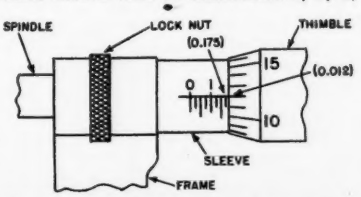


Fig. 2. Every line on the sleeve of an English type micrometer indicates 0.025 in. Since one complete revolution of the thimble moves the spindle 0.025 in. each of the 25 thimble graduations equals 0.001 in. In this case the reading is 7 x 0.025 plus 0.012, or 0.175 plus 0.012, or 0.187

etc. This represents 100, 200, 300, etc. thousandths inch or 0.100, 0.200, 0.300 in. The beveled edge of the thimble is divided by 25 graduations, each fifth one being numbered for convenience in reading. Since one complete revolution of the thimble moves the spindle 0.025 in., each of these 25 thimble graduations equals one thousandth (0.001) in.

To read a measurement in thousandths of an inch, referring to Fig. 2, first note the number of hundreds of thousandths indicated by the highest figure visible on the sleeve. This is 1 and represents 0.100. Write this on a piece of paper. Then multiply the number of graduations visible between the sleeve figure and the thimble edge by 0.025 (3 $\times$ 0.025 equals 0.075). Add this to the first number. Next note the number of the line on the thimble that coincides with or has passed the long parallel line on the sleeve. In this case it is 12 and we add it to the figures on paper. Now add these and the result is 0.187, which is the measurement shown.

It is well to practice such measurements till the method of reading them becomes familiar. Then discontinue totaling the amounts on paper and add them mentally. However, it is a good idea to check your mental answers by later calculating on paper to be sure you are able to obtain the correct answers in your mind. In order to thoroughly familiarize yourself with micrometer reading you should practice daily for several days. This will give you a greater degree of facility.

Some micrometers are provided with half thousandths divisions on the thimble. This means that there are 50 divisions instead of the usual 25. This feature permits greater accuracy in measurements.

The Metric Type Micrometer

A Metric graduated micrometer employs the same principle of measurement as the English graduated type, but it is necessary to remember that there are certain differences in graduations. In the Metric micrometer the pitch of the spindle screw is 0.5 mm, thus one revolution of the spindle advances or retracts the measuring face 0.5 mm. The micrometer sleeve is graduated in mm,

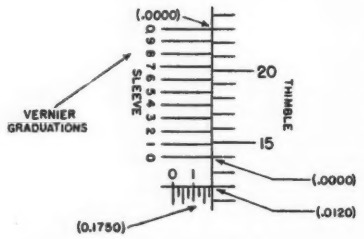


Fig. 3. On the vernier micrometer, the vernier graduations are parallel with the long parallel line on the sleeve and are numbered from zero to zero. The total reading is 0.1870

from 0 to 25, therefore each two revolutions of the spindle advances it through a distance equal to 1 mm on the sleeve. The thimble is graduated in 50 divisions, every fifth one being numbered. Thus when the thimble is rotated one graduation, the spindle advances 1/50 of 0.5 mm or 1/100 mm (0.01 mm).

The reading therefore equals the number of mm showing on the micrometer sleeve beyond the beveled edge of the thimble plus the reading in hundredths of a mm indicated on the thimble. Thus if 7 mm were showing on the micrometer sleeve and the 15th graduation on the thimble coincided with the long parallel line on the sleeve, the reading would be 7 and 15/100ths mm or 7.15 mm.

One style of Metric micrometer is designed to be read in twenty-five ten-thousandths of a mm. The spindle screw has threads of 0.5 mm pitch and the oversize thimble has 200 graduations, each tenth one being numbered. Since each graduation on the thimble moves the spindle 1/200 of 0.5 mm, this equals 1/400 mm or 25/10,000 mm (0.0025 mm).

The Vernier Micrometer

Some English graduated micrometers are designed to measure in ten-thousandths of an inch. These instruments usually employ what are known as vernier graduations, so named from Pierre Vernier, who invented this system in 1631.

As shown in Fig. 3, the vernier graduations are parallel with the long parallel line on the sleeve and are numbered from zero to zero. The vernier has 10 divisions which equal the space of 9 divisions on the thimble. Thus one division on the vernier equals 1/10 of 9/1,000 in. or 9/10,000 in. The thimble graduations each equal 1/1,000 in. or 10/10,000 in. Therefore, the difference between a vernier division and a thimble division equals the difference between 9/10,000 in. and 10/10,000 in. or 1/10,000 in.

When the micrometer reading is exact in thousandths the zero lines on the vernier coincide with two of the thimble graduations, as shown in Fig. 3. It may also be noted in this figure that the difference between lines on the thimble and those on the vernier at 1, 2, 3, etc. equals 1/10,000 in., 2/10,000 in., 3/10,000 in., etc. Thus at the 1, 2, 3, etc., vernier line coincides with a thimble line, the thimble has moved past the exact thousandth setting 1, 2, 3, etc., ten-thousandths of an inch or 0.0001, 0.0002, 0.0003, etc. inch.

In reading the vernier micrometer, again referring to Fig. 3, when the zero lines on the vernier coincide with any two lines on the thimble there are no ten-thousandths to add. Hence the reading in the figure is 0.187 or 0.1870 in.

Now referring to Fig. 4, the 7th graduation on the vernier coincides with a graduation on the thimble, thus indicating that 7/10,000 in. should be added to the thousandth of an inch reading on the micrometer. Hence 0.1870 plus 0.0007 equals 0.1877, which is the reading in ten-thousandths of an inch.

A few micrometers read in ten-thousandths by a different means. In one type the spindle screw has 50 threads per inch and the oversize thimble has 200 graduations, each tenth graduation being numbered. Thus the reading can be taken directly in ten-thousandths, since 200 graduations × 50 equals 10,000.

In another type, after the measurement setting has been taken as with a regular thousandth reading micrometer, a small auxiliary thimble is turned to bring the graduations in line on both the sleeve and the thimble. This auxiliary thimble is marked in ten-thousandths. Thus the amount of auxiliary thimble movement necessary to align the sleeve and thimble graduations will determine the number of ten-thousandths to be added to the thousandths reading.

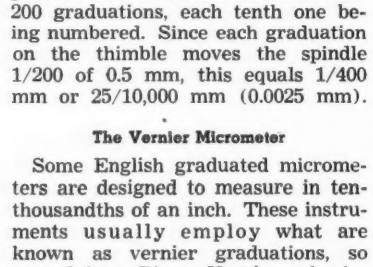


Fig. 4. Since the 7th graduation on the vernier coincides with a graduation on the thimble, 7/10,000 in. must be added to the reading. The reading in ten-thousandths of an inch is 0.1877

The Vernier Caliper

The reading of a vernier caliper is very similar to that of a vernier micrometer except that the divisions differ. This instrument, which was invented in 1851, consists of a graduated blade having a jaw or hook at one end and a sliding jaw that can be moved along the blade and which carries a vernier scale.

As shown in Fig. 5, the vernier consists of 25 graduation spaces, each

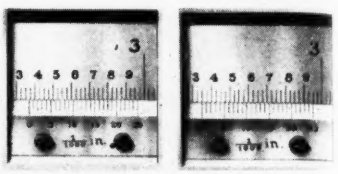


Fig. 5-A (Left). The 18th graduation on the vernier coincides with a line on the caliper blade, indicating a reading of 0.018. Adding this to the blade reading of 2.350, we get a total of 2.368 in. Fig. 5-B (Right). Example of reading with no thousandths showing on the vernier. The reading totals 2.350 in this case

5th one being numbered. The caliper blade is marked off in inches, which are numbered as on a rule, and in 40ths of an inch, each 4th one being numbered. Since each 40th graduation equals 0.025 in., the distance between numbered 40ths equals 0.100 in.

The 25 graduations on the vernier scale equal 24 graduations on the caliper blade. Since each of these caliper blade graduations equals 0.025 in., 24 of them total 0.600 in. Thus one vernier division equals 1/25 of 0.600 in. or 0.024 in. Therefore, the difference between a division on the blade and a division on the vernier equals 0.025 in. minus 0.024 in. or 0.001 in. Hence, when the reading is as shown in Fig. 5, we have 2 in. plus 3 × 0.100 or 0.300 plus 2 × 0.025 or 0.050 on the blade, plus 18/1,000ths or 0.018 on the vernier, which totals 2.368 in.

Hence, the reading shown in Fig. 5 is determined as follows: 2 in. are showing on the blade to the left of the slide. To this figure we add the amounts represented by the graduations on the blade to the left of the zero on the vernier scale. The Fig. 3 represents 0.300 in. (3 × 0.100 in.), and, since each of the unnumbered graduations equals 0.025 in., the 2 between the number 3 and the zero on the vernier total 0.050 in. Therefore, we have 2 in. plus 0.300 in. plus 0.050 in., which equals 2.350 in. To this we add the extra thousandths indicated on the vernier. Since the 18th graduation on the vernier coincides with a line on the caliper blade, this indicates a reading of 18 thousandths or 0.018. Adding this to the blade reading of 2.350 in. we get a

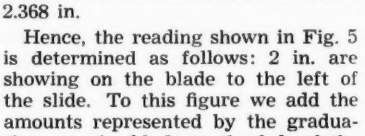


Fig. 6. Universal bevel protractor. The reading shown is 12 deg. 50 min

total of 2.368 in., which is the answer in inches and thousandths of an inch.

Universal Bevel Protractors

Universal bevel protractors use a somewhat different vernier arrangement for reading the graduations on the dial. The disc of the protractor is graduated in degrees from 0 to 90 each way. Some models are graduated in this manner completely around the disc. The vernier scale is graduated so that 12 divisions on the vernier occupy the same space as 23 deg on the disc. The difference therefore between one of the 12 spaces on the vernier and two of the 23 spaces on the disc equals 1/12 of a deg or 5 minutes.

To read the measurement on an instrument of this type, referring to Fig. 6, first note how far the zero line on the vernier has moved beyond the zero line on the disc. In this example it has moved 12 whole degrees. Then, continuing in the same direction, note which line on the vernier coincides with a line on the disc. In this case it is the 10th line, representing 50 minutes (10 × 5 minutes). The reading therefore is 12 deg plus 50 minutes or 12 deg, 50 minutes.

Since the divisions on the disc and on the vernier are numbered both to the right and left from zero, the readings on the disc and on the vernier are taken either to the right or left, depending upon the direction in which the zero on the vernier is moved.

A word of caution about micrometers. Use only light pressure when taking measurements. Never jam the spindle against the anvil. To do so may spring the frame and destroy the accuracy of the instrument. And, of course, never use a micrometer as a substitute for a clamp or a hammer, or for any other purpose than as a precision measuring instrument.

PAINTING RADIATORS

BECAUSE RADIATOT painting is difficult and involves a great deal of preparation work, it is often done in a haphazard manner. Before painting all surfaces should be scraped or sandpapered in order to remove rust and old loose paint. If the paint is to adhere properly all grease should then be removed by turpentine or benzine.

Because radiator maintenance is apt to be put off until the last moment, blistering is a very common difficulty. The radiator must not be heated until the paint or enamel has thoroughly dried and is hard. Turpentine, paint, and cleaners are volatile and explosive. They should not be used near an open flame or while smoking.

LETTERS AND COMMENTS

WHAT TO DO IF THE WATER LEVEL IS DOUBTFUL

HERE IS *some very sound comment on a point originally raised by Glenn Browning in the July 1947 issue of* POWER PLANT ENGINEERING (*now* POWER GENERATION). *On page 95, July issue, Mr. Browning raised some questions about the procedure outlined in case of low or doubtful water level in the* POWER PLANT ENGINEERING *Questions and Answers book, 8th Edition.*

The following letter was received shortly afterward from Marvin Persinger, who has frequently contributed to the Practical Engineer section. We sent it to Mr. Browning for his comments; and the time required for typing copies, mailing, getting replies from both, and so on, accounts for the delay in publishing this correspondence, with the full permission of both.

Marvin Persinger Says Bottle Up the Boiler

A DISCUSSION has recently been brought up in POWER PLANT ENGINEERING regarding the proper procedure to be followed when the water level of a boiler is out of sight in the gage glass. I must disagree with the emergency procedure as outlined by Mr. Browning in the July issue. Mr. Browning advises that after the heat supply has been interrupted, the conditions of steam flow to prime mover and the feedwater supply should not be altered. In my opinion, this procedure is wrong, and I make this statement with the knowledge that it is outlined as corect in a number of Q. & A. handbooks.

When a low-water emergency exists, the fuel supply should of course be interrupted as quickly as possible. The engineer's next step should be to close both main steam and feed stops, and open the superheater vent. The main steam stop is closed in order to hold pressure on the unit and thus prevent a further drop in water level. If the turbine is permitted to consume steam, the water level will drop rapidly even though the feed is maintained at normal. The feedwater stop is closed immediately to prevent the possibility of thermal shock to the drum metal. The superheater vent is opened to avoid damage due to overheating of the elements. This valve should be throttled to hold temperature below critical and to hold the safety valves on their seats. The boiler should be held under these conditions until the furnace has cooled to the point where exposed metal surfaces will not be damaged. By all means, never gamble and feed water to a boiler when the exact level is unknown.

To fully appreciate the importance of closing both steam and feed stops, it is necessary to consider the typical water-tube boiler and the conditions under which it operates. Most modern boilers operate at high rates of evaporation and water contained in the steam drum usually represents only a few minutes supply.

The drum thickness of such boilers may be 4 in. or more in. high-pressure units. The lower drum section is usually located in such a manner that it receives heat, the intensity of which depends upon heating surface arrangement. The steam drum may be placed in such a manner that it is exposed only to boiler outlet gas temperature; on the other hand, the existing temperature may equal that at superheater entrance. In some present-day designs, the drum is in a position to actually have an unscreened "look" at the radiant zone of the furnace, but in other designs, the drum is entirely removed from the boiler heat zones, and therefore is quite safe even if the water level should drop from the drum.

The under, or exposed, side of steam drums is usually insulated, although they are often applied, sometimes installed bare. Insulation is often applied only to between-row surfaces, while ligaments are left exposed. At any rate, the boiler operator can never be certain that the insulation is in place while the boiler is on the line.

When drums are in a position to receive heat, overheating of the outer skin and thermal stresses, are prevented, of course, by the cooling effect of a normal water level. With low and medium-pressure jobs, the drum outer skin temperature should hold fairly close to that of the water, but with high pressure units the outer skin temperature may be considerably higher due to a greater metal thickness. This is despite the fact that saturation temperature is also higher. If the drum is in a temperature zone corresponding to, say, that of the superheater; even with a thickness of block insulation the gas film at the drum outer skin may well be 1000 F.

Now assume that for some reason the feed supply does not equal the evaporation and the water level drops out of the drum. The metal thickness is no longer adequately cooled, for transfer is now from gas to gas. The outer drum temperature rises rapidly and if the heat supply is not immediately interrupted, the drum may be badly overheated. The inner skin temperature rises much more slowly so that a great temperature difference exists between inner and outer drum surface. The mean temperature of the lower drum is also greater than that of the upper section which does not receive heat except by conduction within the metal section. If water at

a comparatively low temperature is thrown upon the already thermally stressed surface the resulting shock may be tremendous. The magnitude of such stresses should never be under-estimated.

The furnace of a boiler does not cool quickly, therefore the mere act of interrupting the fuel supply does not eliminate the danger of overheating. For this reason, every effort should be made to hold the water level uniform until the furnace has cooled to a safe temperature. Even if feeding at this time does not damage the drum, temperature difference between tube ends and tube seats may make it virtually impossible to maintain tight connections when the unit is returned to service.

The procedure of securing both steam and feedwater stops in event of low water is specifically stated in the operating instruction books of both. Combustion Engineering Co. and Foster Wheeler Corp. and is demanded by the Marine Inspection Service.

The rule outlined is by no means a cardinal one, to be observed in all cases of low water. Common sense should dominate an engineer's reaction. For example, if a feed pump should fail temporarily and the engineer is in full sight of the gage glasses when the level disappears, then logic should tell him whether the unit is in danger when feed is again restored. If the drop is only momentary, the boiler can be overfed until normal level is reestablished. Generally speaking, however, feedwater should never be admitted to a boiler when the level is in question.

Exception is in the case of tube rupture. If this should occur, the operator should feed the unit in order to protect heating surfaces until the furnace has cooled. The draft should be regulated to free the furnace of escaping steam. In extreme cases, it may be necessary to dump the boiler to protect plant personnel.

Baltimore, Md. MARVIN M. PERSINGER

Glenn Browning Discusses Heat Storage and Its Effects

In replying to Mr. Persinger's letter, commenting on my note relative to unknown water level in boilers, and the procedure in such cases, this reply is in part to encourage many others to offer something on this all-important subject and is not merely to defend my opinion, wholly, as published in the July issue; but to bring out many opinions, from which we may all improve our knowledge of the many varying conditions under which such an emergency should be handled.

Mr. Persinger offers some good reasoning, and quotes some excellent authority for his contentions. However, it applies to a limited type of boiler. Mr. Persinger also states that his rule is by no means a cardinal one: circumstances, types and conditions alter cases.

Let's assume that everybody will agree that the fuel supply should be the first thing to eliminate. Some may differ as to the arrangement of dampers regulating the draft. In practically every case, I am for cooling the furnace and gas passes rapidly, by admitting cold air over the fire bed, or through the furnace, to suit the conditions.

The next step as to the feedwater supply and steam outlet arrangement seems to be the bone of contention. Just here I wish to emphasize a very important phase of the operation. From past experience, actual practice, and as witness of such happenings, it has been found that the operator, or engineer, becomes excited, the very thing we should not permit—in most cases it is best that the operator STOP for a minute and completely collect himself; think the circumstances out thoroughly, plan his procedure, then perform his plan calmly, issuing orders in a decisive manner to other personnel. I am convinced it will pay dividends to give this minute of collective thinking and steadiness.

Considering a water-tube boiler as described by Mr. Persinger, we see a large boiler set in tons of masonry varying in temperatures of from 3,000 F to near room temperature. We have here the highest of these temperatures adjacent to the heating surface of the boiler, and as Mr. Persinger says, it doesn't cool quickly. This, for one reason, makes me question the advisability of closing the steam outlet and stopping the feedwater supply.

The reason is, there is enough heat stored up in the setting to continue the generation of steam in the boiler for some time, and at a rate, for a sufficient length of time, that I do not believe the average vent of a superheater is large enough to care for. Thus there is the danger of causing the pressure to rise enough to lift the safety valve or valves.

The sudden lifting of a safety valve in turn affords vent to the boiler's circulation, which, in turn, means formation of more steam bubbles in the tubes, raising the water level definitely. As we do not know whether or not a portion of the upper surface of tubes or drum has become overheated, that would be bad practice.

Another reason I wish to offer why I do not think it advisable to stop the steam outlet and water supply is—So long as the steam is being consumed, and feedwater admitted, it is diminishing the pressure. Again we must reckon with the possibility of a portion of the upper part of the boiler becoming overheated; and we understand when boiler plates or tubes reach a certain temperature, their tensile strength diminishes very rapidly; thus the reduction of pressure under normal operation, I feel is advisable.

There is one thing here I wish to make clear, and that is it is not advocated that there be any attempt to increase the water level in the boiler; but to maintain it as near as possible where it is at the time it is found to be unknown, by operating the supply as it was. This may mean a further decrease in its level; but not so rapid as it would be if the supply should be stopped.

This brings up another question. Suppose the boiler is equipped with automatic feedwater control (and installations as described by Mr. Persinger generally are) then the automatic would respond to low water and supply water too fast. *Right.* Which is more food for thought, and makes another condition of many to be reckoned with.

Also, such insulations are (and all should be) equipped with a by-pass around the feedwater regulator, and it is my contention a good operator, familiar as he should be with his plant, should know how to adjust that by-pass for normal operation. This may be done by consulting his feedwater meter; if no meter, by marking the handle of the valve on the by-pass (by filing a notch in it) and setting it a little tighter than normal, which would insure maintaining the water level to correspond with the boiler's consumption. Certainly this is not an ideal or positive arrangement, neither is there any arrangement ideal when the water level is unknown, but in my opinion, is the best I can visualize under that condition.

But there are many other types of boilers which I believe offer more dangerous problems than the high-pressure water-tube boiler, for different reasons.

1. Boilers of the type described above are most always manned by trained personnel. Boilers of smaller types and lower pressures are erroneously reckoned not so important, and too often the employer feels the cost of the low-pressure installation does not justify the cost of a well-trained operator.

2. The smaller and cheaper units are seldom equipped with dependable accessories to maintain safe operating conditions, and when we find a plant with worn-out pumps, twisted injectors, sticky and leaky valves, then we really need an engineer. But too often he is found in the better plants, where there is more inducement and less dirty work.

Let's consider the type of boiler with a crown sheet from the unknown water level view-point. Now I am getting the "jitters". They are of various types, stationary and portable, which makes the subject more and more complex. The V. T. and the H. R. T. under many different conditions and varying equipment. It really is a subject on which every one should throw in their "two cents worth", and I am sure we will all benefit by it.

Columbus, Ohio GLENN BROWNING

Persinger Agrees the Operator Needs to Keep Calm

I WOULD LIKE to express my appreciation of Mr. Browning's interest in this matter. His remarks are com-

mendable and I'm sure they will prove interesting to all readers.

His advice for calm, quick, thinking during such an emergency is indeed excellent. With the average modern installation, the engineers have but a few precious minutes in which to either rectify the trouble or lose the plant entirely. On two different occasions, I have seen a plant's power supply almost lost, simply because the chief engineer worked himself into a mental state bordering on hysteria. In order to save both boilers, his assistants had no alternative but to ignore his orders.

Regarding the theory of metal quenching if a safety valve blows, due to the inadequacy of the superheater vent to work off the generated steam—if this should happen, and it probably would if normal drum pressure is very near valve setting, I doubt that the momentary slight rise of water level would be hazardous. Have you ever noticed the water level of a "bottled-up" boiler when the superheater safety accidentally blows due to insufficient venting? The level will rise slightly, then take a definite drop in proportion, of course, to the quantity of steam lost.

I agree with Mr. Browning that the fire-tube type of boiler with a crown sheet is decidedly more dangerous from the standpoint of injury to personnel than a water-tube boiler. In this case the advisability of closing the feed stop is even more pronounced because there is little doubt in the operator's mind that the crown sheet is definitely in danger of overheating.

Here is a point not mentioned previously. Suppose for the moment that luckily the steam drum is not overheated, the rapid temperature drop that would take place if the steam valve were left open might prove injurious to both steam drum and turbine, if the installation operated normally at 750 F or more.

Baltimore, Md. MARVIN M. PERSINGER

HE SAYS SPREADER STOKERS DON'T BURN SIZES OF COAL WE SAID THEY DID

I HAVE READ with much interest the article in your November issue on The Spreader Stoker Today. I hoped to find some definite recommendations as to over-fire air and methods of retaining the ash in the furnace.

Permit me to take exception to three statements in this article.

1. "Poor quality coal." In the middle west, which has been the home of the spreader stoker, the quality and preparation of the steam coal produced is the best it has ever been in the history of the coal industry.

2. "Coal sizes ¾ by 0 generally accepted." You may be right on the three quarter top size, but are wrong on the bottom size. Quite universally spreader stokers, especially of the conventional type grates, burn double screened coal.

3. "Fifty per cent is burned in suspension." If a spreader stoker will burn in suspension 50 per cent of ¾ by 0, then why does a pulverized unit require a fineness of 80 per cent through a 200 mesh screen?

I think you will find that the coal ignites in suspension but either falls to the fuel bed to complete combustion, or else enters the boiler passes and ceases to burn.

MAX A. TUTTLE
Combustion Engineer.
Indianapolis, Ind.

In reply we informed Mr. Tuttle that data on use of over-fire air and retaining ash in the furnace are now awaiting publication. We also gave him an opportunity of writing an article for POWER GENERATION *amplifying his comments. To this Mr. Tuttle replied:*

I have been involved in the customer acceptance of one of the larger Indiana coal-producing companies for some time, and feel that I have a rather correct opinion of the fuel requirements of the plants in our general territory. Also, as a member of the Technical Advisory Board of Bituminous Coal Research Inc., I have an opportunity to be in touch with many of the fuel service engineers of the county as a whole.

I know of no installation of conventional mechanical spreader stokers that has been satisfied with coal of the normal mine complement of fines after the second year's operation. As one sales executive expressed it, their reasons vary but the results are the same.

Rest assured that the word "retaining" in my letter of December 17 was intentional. Most fly ash and cinder-return systems work on the principle that if you wear the ash down enough, it will eventually go to the atmosphere with the flue gas, but in a form of float dust. If separated but not returned, the disposal problem becomes acute.

Very few plants, particularly those of more recent construction, are capable of handling the sizes of coal mentioned in your article. My statements were based upon experience in plants which are able to handle these small sizes. Naturally inadequate coal handling systems and fly ash trouble enter into this problem, as well as the uneven fuel bed distribution of the conventional spreader stoker.

Be that as it may, conventional mechanical spreader stokers do not use, by choice, the carbon sizes or dry screened ¾ by 0.

Indianapolis, Ind. MAX A. TUTTLE.

COMPRESSED AIR SYSTEM EXPLOSIONS

I NOTE IN the January number of your paper an article concerning "Spontaneous combustion" in an air-compressor system by H. T. Livingston. In my experience as an engineer and boiler inspector I have ran across this condition a number of times and while it is a rather uncommon occurrence, I think every engineer should be posted on what causes it and how to prevent it. I will relate a typical accident of that kind.

In a certain plant for pumping a municipal water supply by air lift from deep wells, a number of air compressors, steam driven, were used. The cylinders and valves of an air-compressor in operation should be lubricated by special quality high fire test cylinder oil at all times. If a lighter oil of low fire test is used it has a tendency to gum up the cylinders and valves of the compressor and coat the inside of the discharge piping with a coating of gummy carbon deposit and if an air reservoir is used on the system, which is usually the case it leaves a residue of carbon there on its interior which may take fire and either burn quietly or ignite with an explosion. In the plant above mentioned the attendant broached the wrong barrel of light low fire test cylinder oil. After he had used it a few days, the discharge valves got so gummed up that when he started up a cold compressor the discharge valves stuck so badly and refused to open. As a result the air was compressed over and over in the cylinder until a sufficiently high temperature was reached to cause the deposits in the discharge line to take fire and burn. This was accompanied by a considerable explosion which blew the gaskets out of the joints of about 300 feet of discharge piping system to the wells. The piping was heated up so you could burn your hands on it.

Most air compressor systems have an air reservoir system attached to the mains equipped with a safety valve. Generally, the unloader on the air compressor is set to operate at a predetermined pressure and if it fails for any reason and the pressure goes up any higher, the safety valve goes into operation.

On one such system I was inspecting, the engineer in charge told me the safety valve let go unexpectedly and a stream of fire came out of the discharge pipe. He wanted to know "how come". I told him the inside of his tank was coated with oil and had burned out and cleared itself. Sometimes when there is only a little entrained oil, it may burn without much disturbance, again it may cause considerable explosions. Sometimes fusible plugs are installed in air reservoirs when this condition is prevalent and if the tank burns out quietly without much explosion it may heat up the fusible plug and blow it and thus call the attention of the engineer to a condition that needs investigation.

The engineer must understand that if he is compressing air that has a carbon gas in it he is liable to get an explosion just like what occurs in a Diesel engine.

Logansport, Indiana C. C. CUSTER

Weight of Insulation for Pipes

By S. S. ULRICH, *Cunningham-Rudy Company and*
T. H. DICKSON, *Wyandotte Chemicals Corp.*

(See table on page 88)

PROCESS and power design engineers are often confronted with the many tiresome calculations involved in obtaining the weight of pipe covered with the accepted insulation materials for various temperature conditions. This information, whether required for purchase requisitions, design of pipe hangers, estimation of floor loads, or whatever, cannot be easily found in the usual literature.

The authors, in an attempt to reduce the time and labor required to calculate the weights of high-temperature and/or 85 per cent magnesia thermal insulation for any I. P. S. pipe at any of the customary insulation thicknesses, have compiled the accompanying tables.

A few examples will illustrate the ease of use of the table on page 88 of the Practical Engineer and Electrician and saving of time effected.

Example 1. To find the weight per foot of standard thickness insulation on a 6 in. I.P.S. pipe for normal operation at 500 F. From the table it appears that for temperatures under 600 F a single layer of 85 per cent magnesia is indicated, and for a 6 in. nominal size pipe the standard thickness insulation covering weighs 3.12 lb per linear foot.

Example 2. To find the weight per foot of the total insulation on a 12 in. I.P.S. pipe for service at 850 F it is necessary to know the thickness of the low temperature and of the high temperature insulation layers. Let us assume that we are given a standard thickness for the first or high temperature layer next to the pipe and a double standard thickness for the second or magnesia layer.

From our main table on page 88 of the Practical Engineer and Electrician section we see that the weight of standard thickness high-temperature insulation on a 12 in. pipe is 11.8 lb per ft. From the supplemental table below we find the standard thickness of insulation for a 12 in. I.P.S. pipe to be 1½ in. (of course double standard would be 3 in.).

We now consider a theoretical pipe with an outside dimension of 12 in. + 1½ in. + 1½ in. or a 15 in. diameter. The weight of this second layer, from our main table, is found to be 29.5 lb per ft. The sum total is therefore 11.8 + 29.5 or 41.3 lb of combined insulation per linear foot for our 12 in. I.P.S. pipe.

It will be seen, upon inspection, that these tables are also helpful in determining the spacing of pipe hangers, pipe clearances, etc., and should become a welcome and oft-used addition to the files of interested engineering personnel. The authors hope this information will be as valuable for other engineers in their daily work as it has been to them in designing pipe systems.

Supplemental Table of Standard Thickness Dimensions

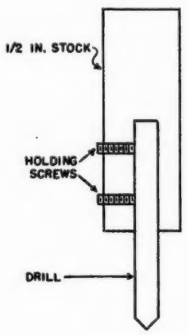
Up to and including	1½ in. nominal pipe size—	⅞ in thick
Up to and including	3½ in. nominal pipe size—1 3/32	in. thick
Up to and including	6 in. nominal pipe size—	1⅛ in. thick
Up to and including	10 in. nominal pipe size—	1¼ in. thick
Over	10 in. nominal pipe size—	1½ in. thick

FOR GRINDING

By W. E. Warner

SMALL, short drills are not only difficult to hold for grinding, but they also overheat quickly. They can easily be held with the simple fixture illustrated.

Take a piece of half inch round stock about 4 in. long and drill a ¼ in. hole about one in. deep in the center. At right angles to this hole, two small holes are drilled and tapped and fitted with set screws. In use, the drill is placed in the center hole, the screws tightened, and the drill ground.



Questions And Answers

Question No. 409

HOW ARE CREEP MEASUREMENTS BEING USED?

DO ANY companies that operate equipment at 1200 psi and 900 to 950 F take creep measurements of piping and superheater elements? If so, what results are being obtained and what use is being made of the information?

New York City — A. A.

Question No. 410

WHAT METHODS REDUCE MAINTENANCE OUTAGE TIME?

WHAT SPECIAL efforts are being made by power plant operators to reduce to a minimum the time equipment is out of service for maintenance?

Rockford, Ill. — C. E.

Question No. 411

HOW DO DIFFERENT COALS AFFECT PRECIPITATOR PERFORMANCE?

DO DIFFERENT COALS burned in the same installation cause any difference in the performance or efficiency of electro-static precipitators?

Pennsylvania — R. L. H.

Question No. 412

HOW VALUABLE ARE PULVERIZER RECORDERS?

MANY ENGINEERS provide temperature recorders on hot air to coal pulverizing mills and also on coal-air mixtures from the mills. What are the operating values of these recorders?

Philadelphia, Pa. — P. M. C.

Answer No. 397

COULD SPONTANEOUS IGNITION HAVE CAUSED THIS EXPLOSION? —CORRECTION NOTE

IN SOME unexplainable manner, the very last word in the comment on this subject by Howard P. Livingston, page 89, January 1948 POWER GENERATION, got changed from the original "watch" to "month." Mr. Livingston intended the last sentence to read: "3. Drain receivers, and all downdrops, or pockets, once each watch." Will readers kindly make this change in their copies of the January issue?—The Editor.

Answer No. 399

SHOULD 115-V EXTENSION LIGHTS BE USED INSIDE BOILER DRUMS?

I HAVE NEVER had any trouble with such lights inside the boiler drum, and never knew of anyone being fatally injured or even seriously burned or injured. It may be that by taking the proper precautions, as well as insisting on the proper tools to work with, makes the difference between safety and injury.

When using an extension light in boilers that are wet or any place where wet or dampness is encountered, make sure of the condition of this light. The bulb breaking is one of the danger factors, so to overcome this, make sure that the fuse is of low amperage. In this manner, as soon as the bulb should break or a short is created, the fuse will blow and the danger of injury will be eliminated.

One of the best means is to make sure that rubber-sheathed cable wiring is used along with the weather and water-proof lighting outlet that is used aboard ships. (Similar to that manufactured by Crouse-Hinds Co.) An extension cord made of this type of outlet can actually fall into water and the light remains lighted and the danger is practically done away with.

As for the use of electric tools in boilers, all these type of tools should be insulated against shock.

If R. H. N. must at anytime use electric tools in wet places, he must first make sure that he or any of his fellow workers are insulated against shock. Insure against risk at all times; this is a *safety must.*

Philadelphia, Pa. T. F. CUNNINGHAM

Trend Is to Lower Voltages, Says Von Dannenberg

THIS QUESTION has been the subject of much discussion past and present. The latest copy of the National Safety Code available to the writer "Recommends" 32 volts or less for extensions used in hazardous locations. There is one user, a large manufacturer, using 6-volt lamps for internal inspection work obtained through a portable transformer with "polarized" plug connections to make incorrect "plugging in" virtually impossible.

Although 115-volt extensions are still in use the normal tendency seems to be toward lower voltages and 32-volt and 6-volt levels enable available equipment to be used. There is also a tendency among employee liability insurance authorities to urge the use of lower voltages for this application. Local authorities ought to be consulted to be certain they have no mandatory requirements. It is noticeable in foreign lands, particularly where authoritarian regulations exist, how the requirements are definitely mandatory.

C. O. VON DANNENBERG

Brooklyn, N. Y.

Use Flashlight Says Rogers

WE, OURSELVES, make it a practice to use flashlights wherever possible, though we do have an extension cord which is highly insulated and the light bulb thoroughly protected.

We believe that a chap by the name of Read, son of the owner of the Read Paper Company in Ithaca, N. Y., was killed when inspecting the inside of a boiler drum with a 110-v cord. In some way either the bulb broke or the insulation was defective and the electric shock which he received killed him. This happened around 1925 or 1926, if memory serves me correctly.

In our own organization we had an electrician who twice received the full force of 6,600 volt shocks and survived. It is obvious that the condition of the person's heart and the degree of insulation given to him by the ground on which he is standing is a larger factor than the voltage.

Au Sable Forks, N. Y.

JAMES ROGERS, II

Answer No. 400

CAN OPERATORS SIT DOWN BETWEEN ROUNDS?

IN ANSWER TO this question as asked by L. E. S., I don't know of any test having been made on plant personnel to determine if they were more or less attentive to their duties when allowed to sit down at their log desks or control stations. I believe that when an operator sits down, if only for a short period, he will be relaxed and this in turn is less tiring. As long as he has his mind on his work and carries out his duties, I believe this would be O.K.

Then on the other hand, if an operator, after making his round, has his mind on his work all well and good, but suppose he gets to day-dreaming about what he will do when he finishes his watch, for example. This way of thinking, especially when allowed to relax for a few minutes, gets to be a habit and in time, may make this type of operator careless.

I believe this depends more or less upon each operator's habits. If he is attentive to his work at all times, then a short sitting spell, while he makes his log up, would be perfectly alright. But take the other type of fellow, also an operator, who makes his rounds a matter of routine and who is apt to overlook some detail from time to time.

Much of the judgment of this matter is up to the type of operators. I feel that an operator who is on his feet during his entire watch, is more attentive due to the fact he will check his equipment more often just to have something to occupy his time. Otherwise the watch gets monotonous.

As L. E. S. mentions it is only for a short period, and whenever nothing important is taking place, I feel that such periods of sitting would be all right.

Philadelphia, Pa. T. F. CUNNINGHAM

Answer No. 405

WHAT'S THE BEST AIRCRAFT NIGHT WARNING FOR A STACK?

Must Consult with CAA; Flood Lights Not Considered Good Method

THIS IS in reply to question 405 by L. B. E. in the January issue on lighting of stacks near air ports.

L. B. E. does not give the diameter or height of his chimney or the type of construction, hence a specific suggestion cannot be given.

Marking and lighting of chimneys and other tall structures, on or near a flight path, comes under the jurisdiction of The Civil Aeronautic Authority and their recommendations and approval will govern.

In general, I have found they do not look with favor on trying to illuminate the top of a chimney with flood lights. The usual practice is to install four red flashers at the top and mid-point, or in the case of structures 150 ft or more in height, at the top and third points.

In some cases, painting with alternate 10-ft bands of white and International orange will also be required.

If the chimney is large and of brick or concrete construction, 3-ft wide service platforms should be built completely around the chimney. The lights should be rigidly mounted to the chimney shell and should be in weather-proof and possibly acid-resistant mountings. An exterior safety ladder should be provided.

If the chimney is small and has an exterior ladder, service platforms should be built on the ladder; and the lights can be attached to an encircling ring on a trolley suspension, so they could be pulled around to the platform for servicing. This arrangement is not recommended for large chimneys, or if a complete service platform is permissible.

If the chimney is of light steel construction and will not hold a ladder or service platform and is not too high, it would be possible to use lowering and disconnecting hangers such as those of the Thompson Electric Co. This would be a last resort as rigid mounting is to be preferred.

However, before making any decisions the CAA should be consulted on the problem.

Garfield, Utah R. A. MARRIOTT

WEIGHT OF INSULATION FOR PIPES
(LBS. PER FT.)

For explanation see page 86

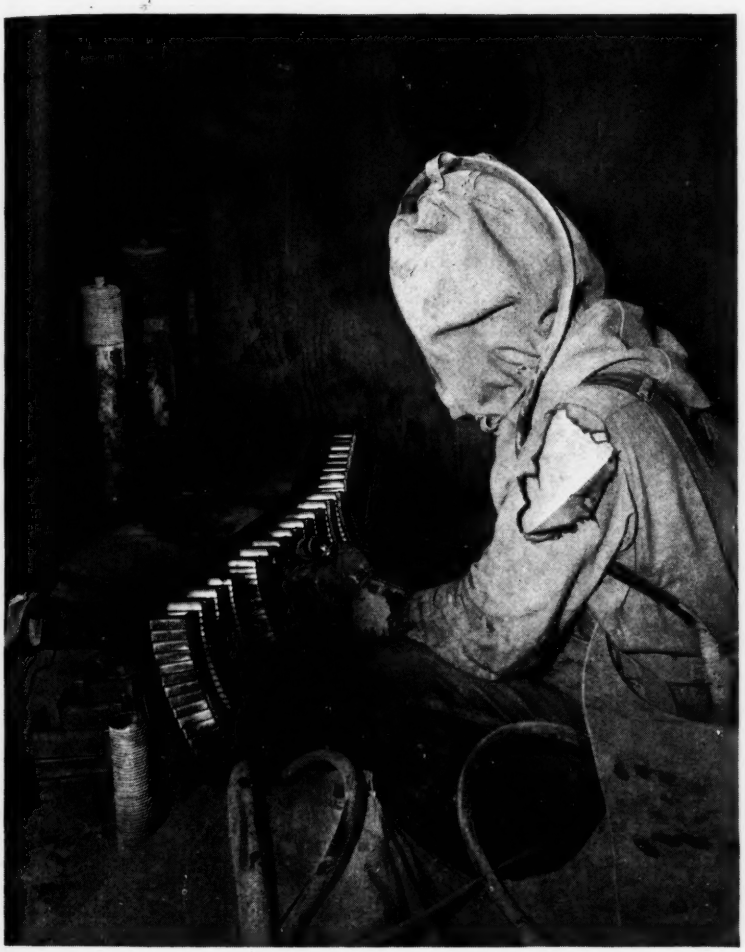
85% MAGNESIA (16# PCF AVER) SUITABLE FOR TEMP UP TO 600 F
HI-TEMPERAT (25# PCF AVER) SUITABLE FOR TEMP OVER 600 F

THICKNESS COVERING (INCHES)	NOMINAL PIPE SIZE												
	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	INCHES
STD. THKNS.	0.54	0.62	0.69	0.80	0.86	1.25	1.43	1.66	1.84	2.23	2.43	2.65	85% Magnesia Covering
	0.84	0.97	1.08	1.25	1.34	1.95	2.23	2.59	2.88	3.48	3.80	4.14	Hi-Temperature Covering
1 1/2	1.24	1.37	1.50	1.70	1.80	2.06	2.32	2.65	2.91	3.17	3.52	3.73	
	1.94	2.14	2.34	2.66	2.81	3.22	3.63	4.14	4.55	4.95	5.50	5.83	
DBLE. STD. THKNS.	1.85	2.02	2.18	2.43	2.56	3.24	3.83	4.30	4.68	5.35	5.73	6.19	
	2.89	3.16	3.41	3.80	4.00	5.06	5.98	6.72	7.31	8.35	8.95	9.67	
2	2.00	2.18	2.36	2.62	2.75	3.10	3.23	3.88	4.23	4.58	4.93	5.32	
	3.13	3.41	3.69	4.10	4.30	4.85	5.05	6.06	6.62	7.16	7.71	8.31	
2 1/2	2.95	3.16	3.38	3.71	3.87	4.31	4.75	5.29	5.73	6.17	6.60	7.10	
	4.61	4.94	5.28	5.79	6.05	6.73	7.42	8.27	8.95	9.64	10.3	11.9	
3	4.06	4.32	4.58	4.64	5.17	5.70	6.22	6.87	7.40	7.92	8.44	9.03	
	6.35	6.75	7.16	7.25	8.08	8.91	9.72	10.6	11.6	12.4	13.2	14.1	

	6	7	8	9	10	11	12	14	15	16	17	18
STD. THKNS.	3.12	3.93	4.40	4.83	5.29	6.94	7.53	8.12	8.64	9.16	9.69	10.2
	4.88	6.14	6.88	7.55	8.26	10.8	11.8	12.7	13.5	14.3	15.1	15.9
1 1/2	4.32	4.84	5.37	5.96	6.48	7.00	7.53	8.12	8.64	9.16	9.69	10.2
	6.75	7.56	8.39	9.31	10.1	10.9	11.8	12.7	13.5	14.3	15.1	15.9
DBLE. STD. THKNS.	7.07	8.95	9.82	10.8	11.7	15.6	16.6	17.8	18.9	19.9	20.9	22.0
	11.0	14.0	15.3	16.9	18.3	24.4	25.9	27.8	29.5	31.1	32.6	34.4
2	6.11	6.81	7.51	8.29	8.99	9.69	10.4	11.2	11.9	12.6	13.3	14.0
	9.55	10.7	11.7	12.9	14.0	15.2	16.3	17.3	18.6	19.7	20.8	21.9
2 1/2	8.07	8.95	9.82	10.8	11.7	12.5	13.4	14.4	15.3	16.1	17.0	18.0
	12.6	14.0	15.3	16.9	18.3	19.5	20.9	22.5	23.9	25.1	26.6	28.1
3	10.2	11.3	12.3	13.5	14.5	15.6	16.6	17.8	18.9	19.9	20.9	22.0
	16.0	17.7	19.2	21.1	22.7	24.4	25.9	27.8	29.5	31.1	32.6	34.4

	19	20	21	22	23	24	26	27	28	30	32	33
STD. THKNS.	10.7	11.3	11.8	12.2	12.8	13.3	14.4	14.9	15.4	16.5	17.5	18.0
	16.7	17.5	18.4	19.1	20.0	20.8	22.5	23.3	24.1	25.8	27.3	28.1
1 1/2	10.7	11.3	11.8	12.2	12.8	13.3	14.4	14.9	15.4	16.5	17.5	18.0
	16.7	17.5	18.4	19.1	20.0	20.8	22.5	23.3	24.1	25.8	27.3	28.1
DBLE. STD. THKNS.	23.0	24.0	25.1	26.2	27.2	28.3	30.4	31.4	32.5	34.5	36.7	37.7
	35.9	37.5	39.2	40.9	42.5	44.2	47.5	49.1	50.8	53.9	57.3	59.0
2	14.7	15.4	16.1	16.8	17.5	18.2	19.6	20.3	20.9	22.3	23.9	24.4
	23.0	24.1	25.1	26.4	27.4	28.3	30.6	31.7	32.6	35.2	37.4	38.2
2 1/2	18.8	19.6	20.5	21.4	22.3	23.1	24.9	25.7	26.6	28.4	29.6	31.0
	29.4	30.6	32.0	33.4	34.8	36.1	38.9	40.1	41.6	44.4	46.3	48.4
3	23.0	24.0	25.1	26.2	27.2	28.3	30.4	31.4	32.5	34.5	36.7	37.7
	35.9	37.5	39.2	40.9	42.5	44.2	47.5	49.1	50.8	53.9	57.3	59.0

Post-War Research in UNNATURAL HISTORY



THE SECRECY imposed by the recent conflict[1] unfortunately deprived the world of all news of the research of our Unnatural History Staff. Indeed, come to think of it, our last communication from the staff was in August 1937[2] when it discovered the Graver Catta Pilosa in the bleak region around East Chicago, Indiana. Quite obviously the members of the staff with their unnatural insight into any future having to do with work saw the war coming and found places on this planet sufficiently removed from draft boards to permit them to remain in their usual state of somnolence.

Just what put an end to their state of quiescence will probably never be known but, now, suddenly, without the slightest warning, the entire staff has come to life with an earth-shattering discovery somewhere in the deep south, suh—yes suh, the de-e-e-p south.

Somewhere between the Swanee River and Unadilla,[3] our chief curator of Unnatural History was picked up by the local constabulary. Strangely enough he was upright when found wandering in the bogs below Oak Ridge with a radioactive mint julep in one hand and a curious photograph in the other. After some persuasion, some of it with a caoutchouc implement, he was induced to part with the picture. The julep, however, could not be pried loose and despite a reading of 10 Roetgens on the Geiger counter he insisted on guzzling it. Meanwhile he kept muttering something about Klanikus--Turbanikus Klanikus.

The significance of these esoteric mutterings might have remained a mystery forever had not the other members of the Unnatural History staff been rounded up by the posse; they identified the picture at the "show-up" the following morning insisting that it was a picture of Kukluxklanikus, a member of a strange subhuman species found only in the wilds of Alasippi—a region in the deep south, suh! Neither carnivorous nor herbivorous, the creature has no mouth, eyes, ears or nose[4] but is equipped with a built-in radar which serves as its sensory mechanism. A flexible wave guide designed for a frequency of 32,000 mc, made of caoutchouc[5] constitutes its only connection with the external world. It does quite well, however.

But, listen! Maybe you won't believe this—the creature lives on turbine blades. Strange? Well, not to our Unnatural History staff. Orson Welles[6] claims that kukluxklanikus is a lost member of the attacking force from Mars which descended on earth several years ago in an ill-conceived and futile attempt to capture Hoboken and that normally, on Mars, he lives on—well, what do you suppose—Marzipan, of course. On Earth, however, Marzipan costs three bucks a pound and so in desperation, Klanikus has turned to a diet of turbine blades to fortify his iron constitution.

Our Unnatural History staff claims that this picture was snapped when the creature had half devoured the high-pressure unit of a 40,000 kw turbine at Venice No. 2 station near St. Louis. Union Electric Co. officials, however, say, this is just so much hogwash—that it is nothing of the kind, that it is only a picture of one of their maintenance men cleaning the stationary element of a turbine by blowing compressed air on the blades and using fly ash as an abrasive. To this, the Unnatural History boys merely reply, nuts, and stick to their story.

[1] The war.

[2] Another Chapter in Unnatural History," Power Plant Engineering, August, 1937. Page 452.

[2a] Boy! You never saw the likes of this before—a footnote of a footnote. Well, anyway, if you are interested in other Chapters of our Unnatural History course, see "Startling Developments in Unnatural History," Power Plant Engineering, April, 1935, page 204, and "Further Progress in Unnatural History," Ibid, June, 1936, page 320.

[3] Judy Canova's home town. It's in Gawgah.

[4] Here we could put in the old gag about, "Well, how does it smell?" but this whole account smells bad enough without it, so we'll let it pass.

[5] Rubber to you, pal.

[6] Rita Hayworth's ex-husband. He couldn't keep her.

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

The Significance of the Nuclear Reactor in Atomic Development

As pointed out in this article, the nuclear reactor is at once the most amazingly simple as well as the most important device, man has ever invented. Little more complicated than a pile of bricks it has unlocked the deepest mystery of the Universe. It is the source of an astonishing quantity of radiation extending over a range which includes the infra-red as well as the highly penetrating gamma rays. Only five years old the nuclear reactor is bound to play an increasingly important part in all fields of atomic development in the years to come. Enriched piles also will be developed

By **ANDREW W. KRAMER** *Editor, Power Generation*

THE SUCCESS of the first self-sustaining nuclear chain reaction was commemorated on December 2, 1947, by the dedication of a plaque on the West Stands of Stagg Field on the University of Chicago Campus where the experiments with the first pile were carried out five years ago. The plaque reads:

On December 2, 1942
Man Achieved Here
The First Self-sustaining Chain Reaction
And Thereby Initiated the
Controlled Release of Nuclear Energy

Curiously enough, while the speakers at the ceremony included such famous scientists as Enrico Fermi, designer of the pile, Farrington Daniels, chairman of the Board of Governors of the Argonne National Laboratory, Robert Bacher of the A.E.C. etc., only a comparatively small number of persons were present. Yet the event commemorated by this ceremony marks an achievement that will go down in history among the greatest that man ever made, for on that day he unlocked the deepest mystery of the Universe.

Much has been said and written about the atomic pile since its existence was first disclosed the day the atomic bombs were dropped on Japan in August, 1946. Amazingly simple in its basic construction it nevertheless is one of man's greatest achievements. Never, in all of history, has a fundamental discovery been applied to practical purposes so quickly. In less than two and one half years after its discovery the atomic pile was manufacturing the raw material needed for the atomic bomb. The pile is also a source of valuable radioactive isotopes and great quantities of heat. This heat will, some day, supply our power needs.

The greatest yield of the atomic pile, however, is not heat, nor plutonium, nor radioactive isotopes, it is something that is beyond any estimation of value. This product cannot be seen, felt, tasted, weighed or valued in terms of money; it is knowledge. The nuclear reactor is the greatest source of knowledge man has ever tapped—the key to an entire new sector of the Universe. It opens up new opportunities for study, undreamed of even a few years ago. It provides us with the means for penetrating still further into the heart of the atom. There are still a great many mysteries there — mysteries which we can only suspect but can have no inkling of today. Binding energy[1] for example; we speak quite glibly about the binding energies of the elements composing the nucleus, indeed, we actually calculate them, but nobody knows anything about them, what they are, nor what effect

[1] The binding energy is the difference between the mass of an atom and the mass of its components separated. This provides a measure of the energy of cohesion of a given nucleus, or the energy required to break the nucleus into isolated component particles. This difference commonly called the mass defect, is also called the binding energy. See Table I.

they have beyond the confines of the nucleus. Do they have anything to do with gravity? We know gravity exists, we know the laws governing its operation but we have never discovered what it is, nor can we generate it. We know to some extent what electric and magnetic fields are and the relations which exist between them but we know practically nothing about the gravitational field. Perhaps, further knowledge of the binding force in the nucleii of atoms will throw light on the true nature of the gravitational field.

In the proton, the neutron and the electron we have reduced all of the material Universe including the radiant energy which is the counterpart of these elements, into only three entities. These nuclear particles, that is, the neutrons and the protons, are held together by the strongest forces in existence, forces which are a million times stronger than the electric forces holding the electrons to the nucleus. When we know more about the nature of these forces and about the particles themselves, we will know more about the ultimate nature of the Universe; perhaps we will know what gravitation is, even though we might never hope to control it.

The nuclear reactor provides us with a means for extending our research and investigations into these matters on an enormous scale. In the first few years, of course, we can use it only to study the simplest, the nearest things—things we already know something about, but the disclosure of one fact will uncover another and the steady accumulation of new facts will in time yield information of which we have absolutely no knowledge today.

A Million Tons of Radium!

Consider what the nuclear reactor means in terms of radioactivity alone. In the operation of the nuclear reactors at Hanford, Washington, a terrific amount of radioactivity is built up in the piles, the equivalent, say, of around a **million tons of radium!** Think of this in relation to the fact that only two, or at the most three, pounds of radium have ever been extracted in all the years since its discovery. We all know how dangerous the radiation from even a few milligrams of radium is. Then think of the radiation from a million **tons!** This radiation is extremely deadly but it may also save your life. Radioactive isotopes[2] are already in use in medical diagnosis and experiments seem to indicate that they may be of value in the treatment of malignant cancer.

Here, of course, we are primarily interested in power, that is in the development of methods and plants permitting the use of nuclear energy as a source of power. As has been pointed out frequently in these columns, though the principle is clear, the actual construction of a nuclear power plant is some years away because of the necessity of first solving a number of difficult engineering problems. In the ordinary course of events it may be 20 or 25 years before we see any large scale practical development of nuclear power plants. It could be done much more rapidly if we were willing to spend sufficient money and effort. If we put as much effort into the development of a nuclear power plant as we did on the development of the atomic bomb, it is quite possible that we should have an atomic power plant in operation by the end of 1949. It might not be the most efficient or most effective power plant that we could build but it would work.

But we will not spend the money. Since we still have adequate coal and oil resources to meet our immediate and near-future needs there is no economic incentive to spur us on in any such intensive development. It might be better for mankind if all the present coal, oil and gas resources of the world would be exhausted in say five years. Then we really would make an intensive effort to develop nuclear energy for power purposes and *we would do it.* We would *have to do it.*

This brings up the question regarding the amount of fissionable material available in the world. When the atomic bombs were dropped on Japan in the summer of 1945 there was a general impression that uranium was a rare element and that it was unlikely that enough of it existed in the Earth's crust, to make the development of atomic energy for power purposes practical. Ample evidence has been submitted since that time to prove that this view was erroneous. Actually, uranium is far more plentiful than silver or mercury or gold. At the present time only the richest deposits are being used but uranium is contained in the Earth's crust in enormous quantities in very dilute ores. This does not mean that these dilute deposits are unworkable; indeed current mining practice recovers gold profitably from ores that contain as little as 0.3 parts of gold per million of ore. On the average, uranium is present in the Earth's crust at an average concentration of 6 parts per million. Actually, therefore, a handful of rock or gravel or sand picked up anywhere on Earth contains some 20 times as much uranium as is needed in the case of gold ore to make it commercially usable.

In other words, the uranium fuel reserves of the earth are stupendous. For the first time since man began to use mechanical power, he has available a virtually unlimited source of energy. As time goes on, more economical methods will be found to extract uranium from low grade ores and we, therefore, have deposits of energy yielding minerals which will carry the human race through many centuries. Atomic power itself will, no doubt, make the recovery of uranium from these low-grade ores possible.

In thinking about uranium as fuel one must not make the mistake of regarding only the U-235 as fissionable. U-235, as is now well known,

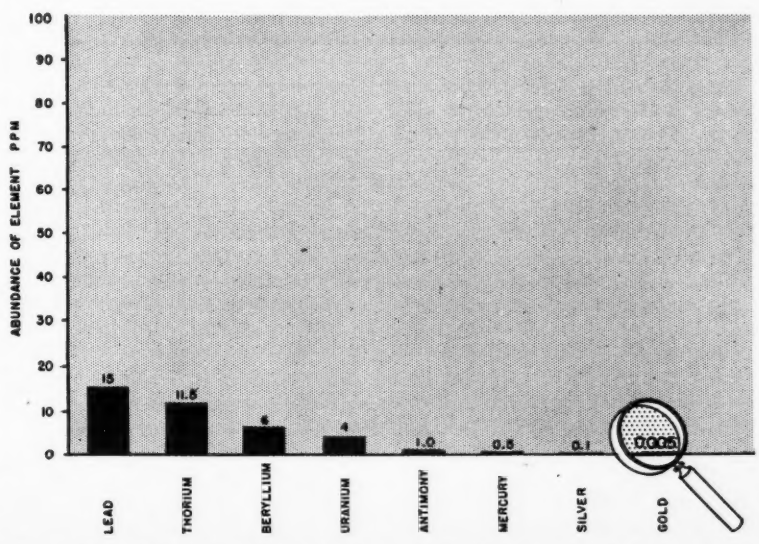


Fig. 1. Chart showing the relative abundance of uranium as compared to some of the other commonly used elements

[2] Radioacttive Isotopes as Tracers. By Andrew W. Kramer, Power Plant Engineering, Part I, October, 1947, p. 102; Part II, November, 1947, p. 105.

is present in purified natural uranium only to the extent of 0.7 per cent. The rest, more than 99 per cent, is U-238.

All Uranium Is Useful Fuel

In the nuclear reactor, only the U-235 is fissionable but the U-238 can also be consumed in the pile. In other words, *every atom of, say, a pound of highly purified natural uranium is atomic fuel.* That this is so will be clear from a brief consideration of the action of the nuclear reactor. When an atom of U-235 undergoes fission as a result of the capture of a slow neutron, it produces on the average slightly more than two new neutrons. One of these two new neutrons must, of course, be absorbed by another U-235 atom to sustain the chain reaction. One of them *must not be absorbed by U-235* —it must *not*. If that second neutron is absorbed by another atom of U-235, the rate of reaction will be doubled and if that happens through another cycle it will be quadrupled. And so on. If that continued, the pile would vanish in a stupendous explosion in a fraction of a microsecond[3]: indeed, that is what happened at Hiroshima and Nagasaki. There, in the atomic bombs, each of the two new neutrons produced by each fission of U-235, produced fission in two other atoms. The result was the most terrible explosion that man had ever created.

So, in the nuclear reactor, the second neutron must be made to escape or it must be absorbed in some atom that will not fission. As has been described, it can easily be absorbed in the cadmium control rods which keep the reactor under control and a certain number are absorbed in this way. The simplest and the most effective way of absorbing these dangerous *second* neutrons, however, is to absorb them in the far more numerous U-238 nuclei.

And, this is actually what happens in the pile. Atoms of U-238 absorb neutrons and as a result become successively U-239, neptunium 239, and finally plutonium 239. Plutonium, of course, is exactly equivalent to U-235 so far as fission is concerned; indeed, the entire purpose of the great reactors at Hanford, is the production of plutonium which is used in the atomic bombs. Thus, the conversion or transmutation of U-238 into plutonium makes it possible to produce fission in all of the atoms in a given amount of natural tranium. Nature, it seems gave us a favorable deal in the nuclear reactor when she released two neutrons in the fission of a U-235 nucleus for one of these is used to sustain the chain reaction while the other serves to transmute U-238 into fissionable plutonium. In the reactors used at Hanford, the plutonium is removed after a certain concentration is reached but if it were left in the pile it would provide additional fuel to keep the reaction going.

Before the uranium resources were nationalized under the Atomic Energy Act, purified natural uranium cost about $20 a pound. Certainly it does not cost more now, so when it is considered that a pound of natural uranium is equivalent to some 1000 tons of good coal, it will be evident that uranium is a very cheap fuel.

Use of Enriched Pile Will Make Smaller Reactors

There is another aspect to this transmutation of U-238 into plutonium that is of advantage in a "power" type of reactor. By making a pile with a high percentage of U-235 or Pu-239, the pile can be made much smaller than if the pile contained only natural uranium. In such an enriched pile the Pu-239 would, of course, be used up and if it had to be replaced, it might make the pile expensive to operate. However, the U-238 present in the natural uranium added to replace the fuel consumed would itself be turned into Pu-239 and so the supply of Pu-239 is continuously maintained. This makes the "enriched" pile practical.

An enriched pile of this kind using plutonium, and operating apparently without the use of a moderator was announced at Los Alamos, last year. The details of this enriched pile have not been disclosed.

In nearly all considerations of atomic energy, only uranium is thought of as fissionable material, that is uranium-235 and the plutonium produced as a result of fission. There are, however, two other elements which are fissionable provided a source of "fast" neutrons is available. These are thorium and protoactinium. These two elements behave exactly the same as U-238. They can therefore be used in an atomic pile operating on uranium "kindling" and can take over the operation of the pile by transmuting themselves into fissionable atoms. In other words, given a pile containing thorium or protoactinium together with a certain amount of U-235, the fission of the U-235 will release high speed neutrons which then will cause the thorium or the protoactinium to act in the same way as U-238 and thus, transmute itself into fissionable material.

Thus, while neither thorium or protoactinium are nearly so plentiful as uranium, they can help to extend the supply of fissionable material.

Fortunately, we will not need great quantities of uranium. A cube of uranium-235 slightly over 4 ft on a

[3] A pile can, in the absence of delayed neutrons, increase its power by a factor of e or 2.7 in times which are exceedingly short. If, for example, a pile designed to operate at 10,000 kw should get out of control with an excess multiplication constant of 0.10, it will be at a level of 27,000 kw in 0.01 second. Even with fair safety factors designed into the shielding of, and heat removal in, the pile, it is obvious that little time is available to correct any sudden changes before something serious happens.

Table of Mass Defects and the Packing Fractions of Some of the Important Elements

		Mass Defects			
		Mass Units $\times 10^{-3}$	Kg-Cal/-Mole $\times 10^{7}$	Electron Volts Per Atom $\times 10^{6}$	Packing Fraction, Mass Units $\times 10^{-3}$
$_1H^2$	(hydrogen)	2.35	5.05	2.19	1.17
$_2He^4$	(helium)	30.29	65.00	28.20	7.57
$_3Li^6$	(lithium)	34.31	71.31	31.94	5.72
$_3Li^7$	(lithium)	42.01	90.14	39.11	6.00
$_4Be^9$	(beryllium)	62.3	133.7	58.0	6.92
$_5B^{10}$	(boron)	69.2	148.4	64.4	6.92
$_5B^{11}$	(boron)	81.4	174.7	75.8	7.40
$_6C^{12}$	(carbon)	98.6	211.6	91.8	8.22
$_6C^{13}$	(carbon)	103.8	222.9	96.7	7.98
$_7N^{14}$	(nitrogen)	112.0	240.4	104.3	8.01
$_7N^{15}$	(nitrogen)	123.5	265.1	115.0	8.20
$_8O^{16}$	(oxygen)	136.6	293.2	127.2	8.53
$_8O^{17}$	(oxygen)	141.1	302.6	131.3	8.30
$_{18}A^{40}$	(argon)	368	788	342	9.20
$_{22}Ti^{48}$	(titanium)	446	957	415	9.30
$_{26}Fe^{56}$	(iron)	523	1,123	487	9.35
$_{36}Kr^{84}$	(krypton)	783	1,680	729	9.30
$_{50}Sn^{118}$	(tin)	1,080	2,330	1,011	9.15
$_{54}Xe^{132}$	(xenon)	1,190	2,559	1,110	9.00
$_{64}Gd^{158}$	(gadolinium)	1,390	2,745	1,290	8.80
$_{82}Pb^{204}$	(lead)	1,700	3,641	1,580	8.35
$_{92}U^{238}$	(uranium)	1,900	4,103	1,780	8.00

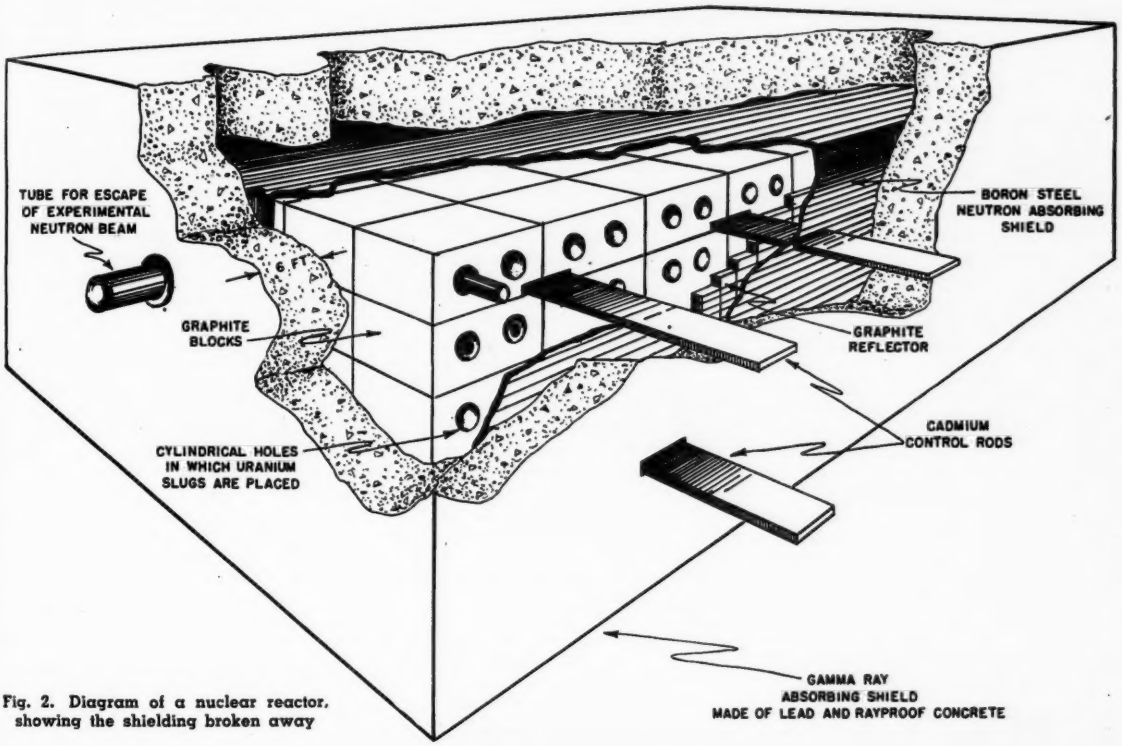

TUBE FOR ESCAPE OF EXPERIMENTAL NEUTRON BEAM
6 FT
GRAPHITE BLOCKS
CYLINDRICAL HOLES IN WHICH URANIUM SLUGS ARE PLACED
BORON STEEL NEUTRON ABSORBING SHIELD
GRAPHITE REFLECTOR
CADMIUM CONTROL RODS
GAMMA RAY ABSORBING SHIELD MADE OF LEAD AND RAYPROOF CONCRETE

Fig. 2. Diagram of a nuclear reactor, showing the shielding broken away

side and weighing only 45 tons could supply all the power used in the United States in a year. At the Hanford plant in Washington where uranium is consumed in the reactors to make plutonium, the actual production of plutonium is probably not more than a few kilograms a day. Yet, so much heat is given off in the reaction that the cold waters of the great Columbia River are warmed to an appreciable extent—several degrees.

While the total amount of heat given off in the Hanford piles is very great it is "low level" heat; heat that cannot be used for any useful purpose. If we are to use the heat generated in a pile for power purpose, it will have to be released at a much higher temperature. As indicated in the article in this section in the February issue, modern steam plant practice involves the use of steam at a temperature of around 1000 degrees which means that the atomic reactor would have to operate at temperatures even higher. At such temperatures the aluminum in which the uranium in the present piles is enclosed would melt and flow like water. Indeed, for power purposes, the whole technique of the uranium pile will probably have to be altered. This, no doubt, will take considerable time.

The one thing that the nuclear reactor could do at the present time with only little additional development would be to supply hot water or low pressure steam for the heating of buildings and for process work in factories. This application lacks the glamour of the atomic bomb or the mystery of radioactive tracer work but is very important. Of all the fuel used in the United States by far the greater proportion is used for heating buildings. To keep the coal-burning buildings of New York warm for one day in winter takes about as much energy as is contained in *25 atomic bombs!* For large heating applications, such as a central heating plant for a medium size or large city, the atomic reactor is almost ideal. It provides, a noiseless, smokeless, compact source of heat of almost unlimited capacity and it may be that in the years to come all of our cities will be heated in this manner.

We still know very little about atomic energy. Compared to radio, we are about where we were when Marconi sent his first wireless signals a distance of 9 miles across Bristol Channel in 1897. So far, we have been able to establish a self-sustaining chain reaction only with the use of uranium. Perhaps, some day, further knowledge will enable us to extend this principle to other, more common elements. At the present time various elements are transmuted in the atomic piles at Hanford. Nitrogen, comes out as carbon; gold comes out mercury; sodium is turned into magnesium. These transmutations are, of course, on a very small scale but it is possible that some day we may learn to perform them on a scale that would make them commercially feasible. Suppose, for example, that we could make copper, silver, tungsten or gold out of an element as plentiful as, say, silicon; suppose we could turn it into any metal we wanted. Would that be good? Would it solve all our economic problems? Whatever would be the consequence from an economic or social standpoint, it would certainly produce a lot of heat.

Suppose We Made Copper

In the transmutation of uranium into plutonium there is a heat release equivalent to that of about 1000 tons of coal for each pound of plutonium produced. This, of course, involves a 200 MEV fission reaction. Other atomic reactions are not nearly so violent and if we were able to transmute silicon into copper for example the heat produced might be equivalent to that of only 5 tons of coal per pound of copper produced. Copper, unlike uranium, is needed in large quantities; to make the process worthwhile, it would be necessary probably to make at least 100 tons a day. The reaction therefore would produce an amount of heat equivalent to 100 $\times$ 2000 $\times$ 5 or 1,000,000 tons of coal per day.

Now 100 tons of copper is not very much and if we produced copper by this method we probably would want much more. Suppose we made 500

ATOMICS

tons per day. This would release an amount of heat equivalent to that released by the burning of 5,000,000 tons of coal per day!

This heat would have to be wasted —thrown away; it could not be used for anything since the plant would have to be located far from any city because of the extreme danger from radioactive radiation. It would almost of necessity have to be carried away by water as the heat from the Hanford piles is carried away by the waters of the Columbia River. But the heat from 5 million tons of coal per day would heat 25 billion tons of water from freezing to the boiling point! If it were the Columbia River, the entire river would be boiling hot. Most of this heat would be transferred to the atmosphere in the form of great clouds of steam or water vapor, and this would seriously change the weather conditions throughout a great region; indeed, it would produce a permanent local hurricane.

The heat release from such an operation would constitute only one of several serious problems. The radiation from the radioactive by-products would be another source of difficulty. The copper itself would be highly radioactive and it might have to be stored in an isolated place for a long time before it could be used for anything. There would be innumerable radioactive by-products some of which might have long half lives. The cooling water itself would be radioactive and the vapor discharging into the atmosphere would carry the radioactivity over great stretches of the Earth's surface. In short, there would be problems no end.

Fortunately, we do not have to face these problems tomorrow. There probably will be ample time to work out the solutions to them before they become realities. Our first task is to learn more; to get more facts in regard to nuclear energy phenomena. The atomic pile provides us with the opportunity to do this. It is only 5 years since the first self-sustaining nuclear chain reaction was started. This formed the beginning of a chain reaction in knowledge and experience that will continue to a point of development far beyond anything we can imagine today. In the fission of uranium we attained an energy level some three million times greater than anything we had before. We all know what the invention and subsequent development of the steam engine did for the human race. This raised man's energy level from about 1/10 of a horsepower per capita to something between 25 and 100 horsepower today. Nuclear energy raises this level immeasurably. Only time will tell what it will do.

A Plea for International Understanding

By ALBERT EINSTEIN

I am most grateful to the Foreign Press Association for granting me its Award in appreciation of my modest efforts on behalf of a great cause[1]. My happiness is dimmed, however, by a consciousness of the menacing situation in which human society—shrunk into one community with a common fate—finds itself. Everyone is aware of that situation, but only a few act accordingly. Most people go on living their every-day life; half frightened, half indifferent, they behold the ghostly tragi-comedy that is being performed on the international stage. But on that stage, on which the actors under the flood-lights play their ordained parts, our fate of tomorrow, life or death of the nations, is being decided.

It would be different if the problem were not one of things made by Man himself, such as the atomic bomb. It would be different, for instance, if an epidemic of bubonic plague were threatening the entire world. In such a case conscientious and expert persons would be brought together and they would work out an intelligent plan to combat the plague. After having reached agreement upon the right ways and means, they would submit their plan to the governments. Those would hardly raise serious objections but rather agree speedily on the measures to be taken. They certainly would never think of trying to handle the matter so that their own nation would be spared whereas the next one would be decimated.

But could not our situation be compared to one of a menacing epidemic? People are unable to view this situation in its true light, for their eyes are blinded by passion. General fear and anxiety create hatred and aggressiveness. The adaptation to warlike aims and activities has corrupted the mentality of man; intelligent, objective and humane thinking has hardly any effect and is even persecuted as unpatriotic.

There are, no doubt, in the opposite camps enough people of sound judgment and sense of justice who would be capable and eager to work out together a solution for the factual difficulties. But the efforts of such people are hampered by the fact that it is impossible for them to come together for informal discussions. I am thinking of persons who are accustomed to the objective approach to a problem and who will not be confused by exaggerated nationalism or other passions. This forced separation of the people of both camps is one of the major obstacles to a solution of the burning problem of international security.

As long as contact between the two camps is limited to the official negotiations I can see little prospect of an intelligent agreement, since considerations of national prestige as well as the attempt to talk out of the window for the benefit of the masses make reasonable progress almost impossible. What one party suggests officially is for that reason alone suspected by the other. Also behind all official negotiations stands — though veiled—the threat of naked power. The official method can lead to success only after spade-work of an informal nature has prepared the ground; the conviction that a mutually satisfactory solution can be reached must be gained first; then the actual negotiations can get under way with a fair promise of success.

We scientists believe that what we and our fellow-men do or fail to do within the next few years will determine the fate of our civilization. And we consider it our task to help people realize all that is at stake, and to work, not for appeasement, but for understanding and ultimate agreement between peoples and nations.

It seems to me that the foreign journalists in this country, when they bestowed their Award upon a scientist, must have been led by similar considerations as those which I have expressed here. May they succeed in contributing to the general acceptance of that point of view.

[1] Dr. Einstein's remarks were addressed to the members of the Foreign Press Association to the United Nations on November 11, 1947, in accepting the Association's awards as chairman of the Emergency Committee of Atomic Scientists. The award was given "in recognition of his valiant effort to make the world's nations understand the need of outlawing atomic energy as a means of war, and developing it as an instrument of peace."

Where to Put Overfire Jets

Modern jets are money-savers . . . Lack of sufficient air causes smoke . . . Effective use of turbulence . . . Height of jets above fuel bed is one determining factor . . . Front wall location of jets . . . Traveling grate reacts favorably . . . Mechanical spreader stokers aided by jets . . . Jets overcome lack of combustion space . . . Visual aids for the operator . . . Cases cited

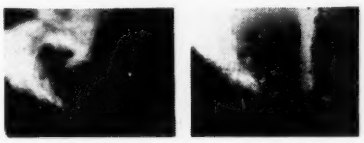
By **WILLIAM S. MAJOR**, *Development Engineer, Bituminous Coal Research, Inc*

INCREASING public demands for the reduction of air pollution have prompted more and more commercial and industrial plants to install modern overfire jets for smoke abatement. Jets are a natural for smoke abatement since they strike at the source of the smoke problem. They provide the turbulence and oxygen, close to the fuel bed, to burn the volatile matter from coal before smoke can be formed. Already over 5,000 stationary plants have installed overfire jets and 32 of the nation's railroads have nearly 2000 locomotives equipped with jets for periodical use in smoke control.

The idea of using overfire jets for improving combustion and reducing smoke has been used to a limited extent for many years. Earlier jet installations, however, were largely of a make-shift nature since there was no pattern or yardstick for determination of the proper number and size of jets for a specific furnace. Frequently the steam consumption was high for the amount of air fed into the furnace and many steam-air jets were installed with either no muffler or one of questionable silencing value. As a result of the high steam consumption and irritating noise of the jet, many of such jets were only used a short time. Then, too, there have been cases of wall erosion or fuel bed matting due to impingement of the jet stream on the wall or fuel bed.

As our experience with modern overfire jets continues to grow it becomes more and more obvious why earlier jet installations were sometimes only partially successful in smoke control. Many earlier jets provided *too little* and *too late* overfire jet treatment in the furnace because there were insufficient jets to provide adequate turbulence over the complete fuel bed. Furthermore, the jet streams were introduced too high above the fuel bed and were striking a region where some smoke had already been formed by breaking down of hydrocarbon vapors.

A case of this nature has been experienced on the boilers of the "S. S. Virginia" of the Chesapeake and Ohio Railway Company. The initial front wall jet system, installed several years ago, consisted of four steam-air jets located about 30 in. above the top of the fuel bed. It was only partially successful in smoke abatement as the jet streams provided inadequate grate coverage and the air was introduced too high above the fuel bed. This discouraged use of the jets and they were dismantled. Early this year, however, the C. & O. engineers decided to try out another set of jets based upon design and construction principles developed by Bituminous Coal Research. This modern jet system, which is shown on Fig. 1, has now been in service about six weeks. It consists of nine (9) steam-air jets located about 12 in. above the top of the fuel bed. Smoke abatement by means of these modern jets has been extremely gratifying to both the owners and operators. Before the jets were installed No. 4 to No. 5 Ringlemann smoke followed the firing periods and it seldom dropped below No. 2 to No. 3 density during any period of the boat's run between Newport News and Norfolk, Virginia. Using these new and modern jets, smoke of No. 2 density occurs for only about 30 sec after the firing period and then consistently averages not over a No. 1 smoke.



Jets on Jets off

Fig. 2. View through sight hole in right furnace door

In order to appreciate the inherent and practical possibilities of the modern jet for smoke abatement, let us briefly review what causes smoke and how the jet functions. It is generally accepted that smoke is formed by the decomposition of the hydrocarbon vapors. The hydrocarbons when heated to high temperatures with insufficient oxygen to burn them, break down into carbon and soot particles. Since these particles are difficult to burn, the basic problem in smoke abatement is to prevent its formation rather than attempt to burn the smoke. This is where the overfire jet plays its part. It provides adequate oxygen and turbulence close to the fuel bed for burning the hydrocarbons as released from the coal. Figure 2 shows actual furnace views of the gas and flame travel with and without overfire jets in service. Note the lazy, uninterrupted flow of gases above the fuel bed when the jets were not in operation. The other view, with the jets in operation, reveals the swirling and mixing of the furnace gases created by the overfire jet-stream action. This swirling and turbulence provides additional travel of the gases before they encounter the relatively cold surfaces of the boiler. Thus, Turbulence and Time, two important requisites for good combustion, are improved by overfire jets.

Details of methods for using overfire jets were given, as follows, in a

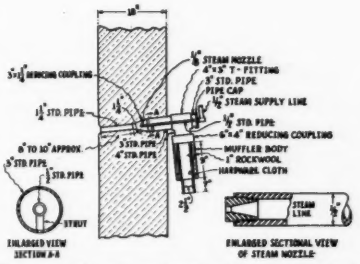


Fig. 3. Cross sectional views of typical steam-air jet with silencer

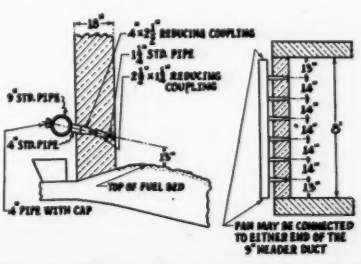

4"x2½" REDUCING COUPLING
1½" STD. PIPE
2½"x1½" REDUCING COUPLING
9" STD. PIPE
4" STD. PIPE
TOP OF FUEL BED
4" PIPE WITH CAP
FAN MAY BE CONNECTED TO EITHER END OF THE 9" HEADER DUCT

Fig. 4. Cross-sectional views of typical blower jet assembly in front wall of furnace

(Editor's Note: Mr. Major is co-author with Richard B. Engdahl of the Revised Technical Report No. VII, issued by Bituminous Coal Research, Inc.)

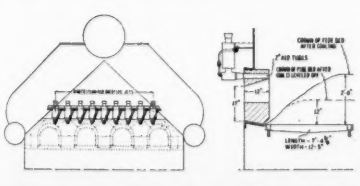


Fig. 1. Application of steam-air overfire jets to hand fired water tube boilers on S. S. Virginia

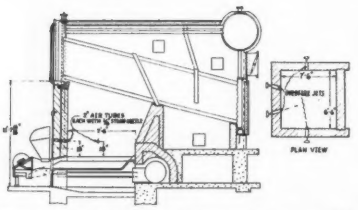


Fig. 5. Application of steam-air jets to 250 hp stoker fired boiler

paper presented by the author before the forty-third annual convention of the Iowa-Nebraska State Association of National Associations of Power Engineers at Ottumwa, Iowa, September 19, 1947.

Figure 3 shows a representative means of constructing a typical steam-air jet from standard pipe and fittings—maintaining basic principles of design. (Another article dealing with jet design and construction will appear in an early issue.)

Front Wall Location

Figure 4 shows a representative means of constructing a six air tube blower jet system for use in the front wall of a furnace. It is constructed of standard pipe and fittings and designed to deliver about 750 cfm of 70 F air with the jet-streams penetrating approximately 10 ft into the furnace. Front wall jets are particularly suitable for multiple retort underfeed stokers since they provide turbulence and oxygen above the "hump" of the fuel bed where there is frequently a deficiency of oxygen.

Figure 5 shows the application of steam-air jets in the front and side walls of a single retort underfeed stoker-fired boiler furnace. Normally it is only necessary to use the jets during grate cleaning periods when the fuel bed is disturbed. Under the operating conditions prevailing at this plant smoke of not over No. 2 density can be maintained during cleaning periods. Then, too, the stack smoke returns to only a haze in a much shorter time after the cleaning period as compared to the performance without jets.

Traveling Grate Locations

With traveling grate stokers both front and rear wall overfire jets have proved effective in smoke control. One theory favors introducing the air from the rear wall. The objective is to force lean gases, coming off from the rear of the grate, toward the front of the furnace and mix them with the rising hydrocarbon gases. The other theory favors introducing the air through the front wall in order to provide the maximum turbulence where the hydrocarbons are released.

An interesting example of the use of both front and rear wall jets on a traveling grate type of stoker is shown on Fig. 6. During periods of heavy steam loads, both the front and rear wall jets are periodically used for maintaining low smoke density. In the summer, when steam demands are light and the active fuel bed is short, smoke can be held to acceptable limits by operating only the front wall jets.

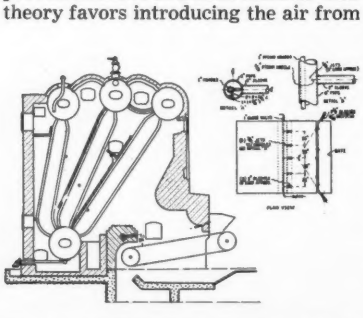


Fig. 6. Application of steam-air jets to chain grate stoker fired 500 hp boiler

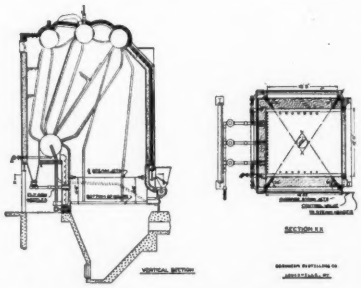


Fig. 7. Sectional and plan views of a 55,000 lb per hr spreader stoker fired unit

Jets with Spreader Stokers

The use of overfire air with spreader stokers not only helps in smoke abatement but also is effective in reducing the emission of fly-ash. Since the hydrocarbons are largely liberated from the coal particles in suspension rather than from the fuel bed, the overfire air should be introduced much higher than with other types of stokers.

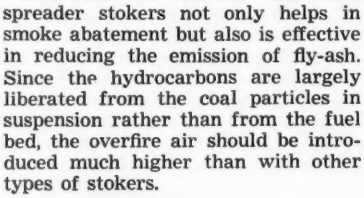


Fig. 8. Jets off—one minute later, jets on

Figure 7 shows sectional and plan views of a 55,000 lb per hr spreader stoker-fired unit at the Bernheim Distilling Co., Louisville, Ky. where the overfire steam-air jets are automatically regulated by a thermopile and electrical control. A continuous smoke sample is drawn from the breeching and passed through a light beam focused on a thermopile. As the density of the passing smoke changes, more or less energy is transmitted to the thermopile and electrical control that actuates and varies the output of the jets. The smoking stack shown on the left hand view of Fig. 8 was made a few seconds after the overfire jets were intentionally shut off—the right hand view was made less than one minute after the jets were again turned on.

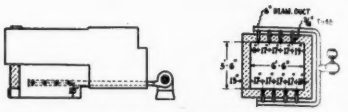


Fig. 9. Application of blower jets in the side walls of a 150 hp hand fired HRT boiler

Low-set, hand-fired, HRT boilers are frequently guilty of rather heavy smoking. The Potomac River Clay Products Company's 150 hp boiler emitted a No. 4 to No. 5 smoke following each firing period, but since the installation of blower jets in the side wall, as shown on Fig. 9, smoke is now held to not over a No. 2 Ringelmann. This density, however, only lasts for about 30 to 40 sec following the firing period and then drops to a density of not over No. 1.

Another example of smoke reduction by means of jets is the installation at the Continental Gin Co., Birmingham, Alabama, as shown in Fig. 10. Overfire air, introduced through the bridgewall, is supplied by a mechanically started motor-driven fan that is placed in service just prior to each hand-firing of the furnace. An automatic time control then takes over and allows the fan to run for approximately 2¼ minutes. This is the time, found by experience, to be sufficient to mix and burn the volatile matter of the coal. Another interesting feature of this job is the use of moderately preheated air, which is accomplished by a pipe connected to the fan inlet that draws air from around the hot breeching. This system raises the air from about 70 F to 160 F and recovers some heat that would otherwise be wasted.

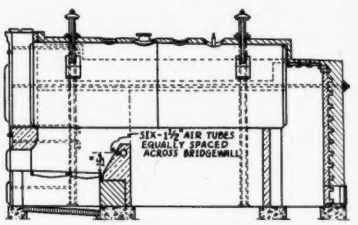


Fig. 10. Application of blower jets to 150 hp boiler in the bridgewall

Overfeed stokers set in a Dutch furnace with limited space for gas and

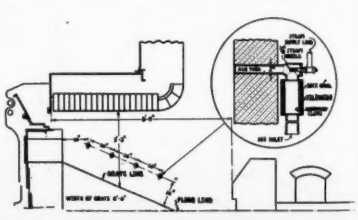


Fig. 11. Application of steam-air jets to overfeed stoker fired boiler

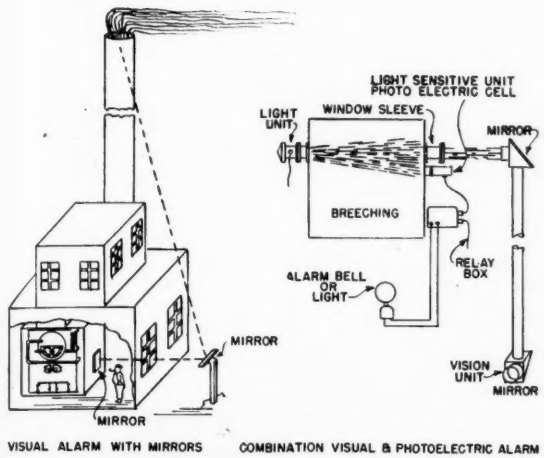


Fig. 15. Different methods for telling when smoke is being made

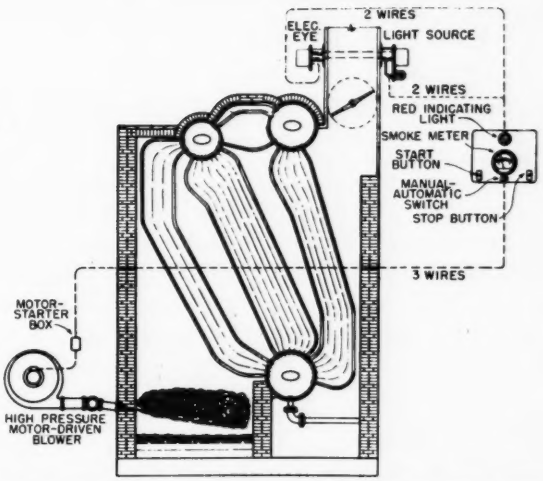


Fig. 16. Automatic overfire jet control on a high pressure blower

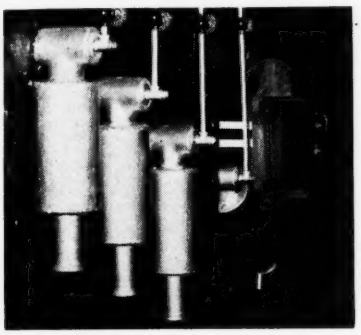


Fig. 12. Showing application of the jets through the side wall of the Dutch oven on the 250 hp boiler in Fig. 11

flame travel are frequently poor performers on the score of minimum smoke. An example of this used to be the Ohio School For Blind, Columbus, Ohio. Figure 11 shows sectional view of the furnace with four steam-air jets located in the sidewall, which give the school a clean stack. Figure 12 shows a close up of the jets with the master control valve and the valves for regulating each jet independently of the adjacent jets. During periods of lighter loads, smoke density can be kept low by use of only one or two of the upper jets.

Many steamboat boilers have even smaller combustion chambers and

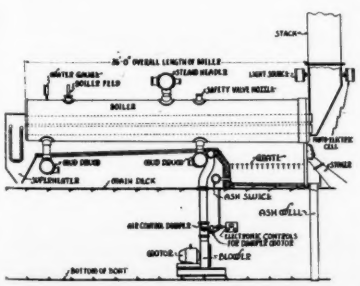


Fig. 13. Overfire blower jet system on low set boiler of a river steamer

less favorable furnace design for good combustion than many of the oldest stationary boilers. Two examples of this type furnace, where jets reduced smoke, are on the boats "Omar" of the Ohio River Co. and Landing Boat No. 210 of the Pittsburgh Coal Co. Figure 13 shows blower-jets in the bridgewall of an old-type river boiler on the steamer "Omar". An electric eye in the breeching and an electronic damper control serve to automatically regulate the overfire air supply, depending upon the smoke density passing through the breeching.

From Fig. 14 showing the boiler furnace of Landing Boat No. 210, it will be noted that the combustion chamber is not only extremely small but that the distance from grate to boiler shell is only 19 in.

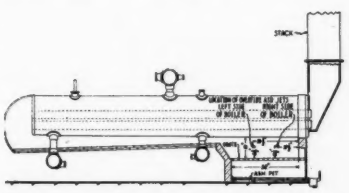


Fig. 14. Overfire steam-air jets to old type river boat boiler. Note small combustion space

When overfire jets are installed for control of smoke density, the attendant should have a ready means for observing the appearance of the exhaust gases. His work, however, can be made easier by a photoelectric cell which receives light through the stack gases and warns him by a bell or light when the smoke clouds the light to the cell more than a minimum and the jets should be turned on. An arrangement of this type is shown in Fig. 15. This type of system can also be extended to provide automatic starting and stopping of either blower or steam-air jets so that the operation is completely automatic. Figure 16 shows a system having all of these advantages.

LARGEST HEAT PUMP IN U. S.

THE LARGEST HEAT pump installation in the United States was described in a paper by J. D. Kroeker and Ray C. Chewning on the subject of "A Heat Pump in an Office Building," presented before the ASH & VE. Mr. Kroeker is a consulting engineer of Portland, Oregon, and Mr. Chewning is a member of his staff.

Automatic switch-over from heating to cooling or the reverse is provided in the installation described—that in the 12-story Equitable Building in Portland. The heat pump—a refrigerating machine which both heats and cools a building—is particularly adapted to regions such as the Northwest U. S. where electric rates are low, according to the Society.

The installation employs well water as the source of heat, and the heat in this water is utilized for heating the building in winter at a cost of only the energy needed for "pumping" the heat to the desired level, the authors stated. Features of the installation described include heat recovery from exhaust ventilation air and heating of ventilation air with waste cooling water.

In another paper presented at the Engineering Society meeting last month, W. E. Johnson, manager of engineering, air conditioning department of the General Electric Co., expressed his opinion that the economics of the heat pump favor commercial as compared with residential installations for the next few years. In his paper the author concluded that for year-round air conditioning in the home the most favorable market for the heat pump will be found in the more southerly part of the U. S. where the design heating requirements are about equal to the design cooling requirements, and where the home owner is able and willing to pay for summer air conditioning as well as heating.

What's New in the Electrical Art?

A great deal is new in the electrical art; so much, in fact, that in some 52 sessions, involving about 200 papers at the Winter General Meeting of the American Institute of Electrical Engineers at Pittsburgh, only the most outstanding developments could be covered. The developments and equipment discussed ranged from microwatts to megawatts, from crystallography to rolling mills. Attended by some 3000 electrical engineers and guests, this meeting of the Institute was one of the most interesting in recent years

THIS YEAR, for the first time in many years, the Winter General Meeting of the American Institute of Electrical Engineers was held in a city other than New York; it was held in Pittsburgh, the week of January 26.

The winter meeting of the AIEE is always the high point of the Institute's yearly activities and the meeting this year was exceptionally interesting and well attended. Over 3000 members and guests registered in the course of the week. Aside from breaking the monotony of always having the meeting in the same place, the change in locale provided a welcome opportunity to make a variety of interesting inspection visits to industrial plants and engineering projects in and around the city of Pittsburgh.

Impressive, for example, was the trip to the world's largest steel-plate rolling mill, the Irvin Works, the newest sheet and tin-plate mill of the Carnegie-Illinois Steel Corp., 13 miles east of Pittsburgh. A "tin can," in ordinary American parlance, signifies a product of little value and dubious importance; but to those who have the privilege of visiting this great steel plant, with its 80 in., continuous, hot strip mill, its cold reducing departments, its continuous electrolytic timing operations, the lowly tin can acquires a status of wonder and importance comparable to that of the Empire State Building or Golden Gate Bridge. For it is largely to make tin plate for tin cans that this great multi-million dollar plant was built.

Blake D. Hull, President AIEE

In few industries has "electrification" been carried out so completely as in the modern steel mill, and in no industry is more electrical energy used. In the Irvin plant with its 344,709 installed motor horsepower, everything is done electrically, with the exception of the gas-fired preheating furnaces. The 80-in. continuous-hot-strip mill alone has drive motors totalling 42,250 hp, the greatest power ever applied to such a mill. Three of the largest motors are rated at 10,000 hp each.

Since the meeting was held in Pittsburgh, steel and mining were two subjects given particular emphasis in the technical program, but the papers presented at the 52 sessions covered practically the entire range of technical activities of the institute. As much attention was given to microamperes as to megawatts. At one end of the scale were the 10,000-hp motors of the Irvin Steel plant; at the other, the ionization counters capable of detecting single electrons.

There were sessions on various phases of electronics; sessions dealing with problems and developments in communication, radio, telephone, telegraph, television; there were conferences on new methods of sound recording, on the development and use of synthetic crystals for electrical filter circuits. New instruments were described, new uses of old instruments shown. The subject of power generation, transmission and distribution was well covered in a variety of papers; other papers described the use of electric power in mining, steel mills, glass plants. There were papers dealing with frequency control of power systems, with the effect of voltage and frequency reduction in conserving load on systems where reserve capacity is low. Two sessions on rectifiers were of outstanding interest. Railroad electrical engineers discussed the relative merits of electric locomotives and diesel and steam units. The variety of subjects discussed, indeed, is almost endless and the ramifications of electrical development were shown to extend into every element of our civilization. The refinement to which electrical techniques have been carried is truly astonishing.

Dr. Joseph Slepian—Edison Medalist 1948
The present Associate Director of the Westinghouse Research Laboratories entered Harvard at the age of 16. Majoring in mathematics, he received his Ph.D. six years later and after study abroad become mathematics instructor at Cornell. A year later he astounded his colleagues by resigning to become a graduate apprentice in the shops of Westinghouse. Here he quickly worked his way into research, and in later years distinguished himself by his remarkable insight into basic electrical phenomena. He was awarded the Edison Medal for his development of improved lightning arrestors, circuit breakers and rectifiers. He is the inventor of the Deion circuit breaker and the Ignitron mercury arc rectifier

X-Ray Thickness Gage

Consider, for example, the X-ray thickness gage used on the hot strip mill at the Irvin mill referred to. This development was described in a paper by Walter Lundahl, and was seen by those visiting the mill later on. It is quite simple; but who, a few decades ago, knowing the delicacy and erratic behavior of X-ray equipment, would have dared to predict the use of an X-ray machine on a rolling mill? Yet this gadget works, amazingly well. It continuously measures the thickness of red-hot steel as it comes from the rolls. The thickness of the sheet is measured by the absorption of an X-ray beam of known intensity as it passes through the moving strip. The difficult problem of stabilizing the X-ray beam has been solved and the indication of steel thickness is given directly in terms of two standard steel wedges.

Electronics has become so much an integral part of electrical engineering

as a whole that it is no longer possible to completely separate electronic developments from general electrical developments. Electronics enters into almost everything that has to do with the electrical art. The whole communication field today is based largely on electronics, as was well reflected by the papers on communication at this meeting. The X-ray thickness gage mentioned in the paragraph above, is, of course, an electronic development.

Supersonic Reflectoscope

Quite different from the X-ray gage yet adaptable to similar applications is the Supersonic Reflectoscope described in a paper by R. B. De Lano, Jr. This is an echo-type flow detection device. It sends a supersonic signal into a thickness of material and, by virtue of the echoes which are returned, an accurate indication of flaws in the material is obtained. Simple enough in principle, yet the circuits are ingenious.

Of interest to operators of large heavy rotating equipment is the electronic oil film thickness gage described by M. L. Greenough of the Bureau of Standards. This instrument has four distance measuring elements mounted on the bearings of the machine, to provide electric signals proportional to the oil film thickness at these locations. A cathode ray tube fed with these signals gives a continuous indication of eccentricity of the shaft.

Less spectacular, yet very important, was a development covered by V. L. Holdaway of Bell Telephone Labs on the quadrature operation of filamentary thermionic gas tubes. Of course, this high sounding title in simple language means merely operating a tube so that the filament voltage, instead of being in phase with the plate voltage, is displaced by 90 deg. This prevents the non-uniformity of filament temperature that characterizes "in-phase" operation, resulting in longer life.

There were many other electronic developments which we cannot begin to touch upon here. For example, there was described a new d-c amplifier stabilized for zero and gain. In other words, this amplifier is stabilized both for conditions where the gain of the amplifier is increased while the input power level is reduced and for a condition where there is zero output for zero input.

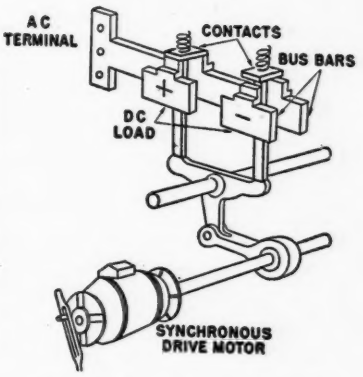
"Printed" circuits received attention under the general subject of electronics, since these circuits are associated with electronic tubes. The technique of the printed circuit is developing rapidly. Not only are conductors printed but similar techniques are being applied to the construction of circuit elements—capacitors and resistors.

Unique is the "optical" radar device for surveying described by W. W. Hansen. This instrument uses radar technique for surveying. Pulses of light are transmitted from a flash lamp to a retro-directive reflector placed at a point whose position is to be determined. The returning light falls on a photomultiplier cell, whose output is amplified to produce a pip on a cathode ray tube. Distance is measured by determining the transit time of the pulse of light.

Many new electronic instruments were described; for example, a direct reading bridge for microwave power measurements; a new broad-band signal generator; microwave frequency measuring devices.

Power Generation

In the field of power generation, there were two papers on Rototrol excitation systems. Rototrol is the name for the electro-dynamic amplifier of Westinghouse, similar to the Amplidyne system of GE. L. F. Liscber presented a paper on General Stability at Low Excitations. This subject resulted as a consequence of the addition of capacitors for power factor correction on the 4-kv distribution system in Chicago, resulting in operation at power factors close to unity at light loads. This, of course, introduces the problem of generator stability at low levels of excitation. The study covered by this paper showed to what extent capacitors may be added to the system without resorting to capacitor switching.



A simple form of contact rectifier

E. B. Strowger and C. L. Avery covered the subject of hydraulic turbine governor specifications; H. W. Warren discussed precise turbine governing.

System operation was discussed in a symposium on Friday afternoon, when four papers were presented discussing controllable factors affecting system load. The effect of voltage and frequency reduction on system load was considered and tests on large systems described. A voltage reduction of from 3 to 5 per cent on large systems, it was shown, can easily result in a drop in system load up to 100,000 kw.

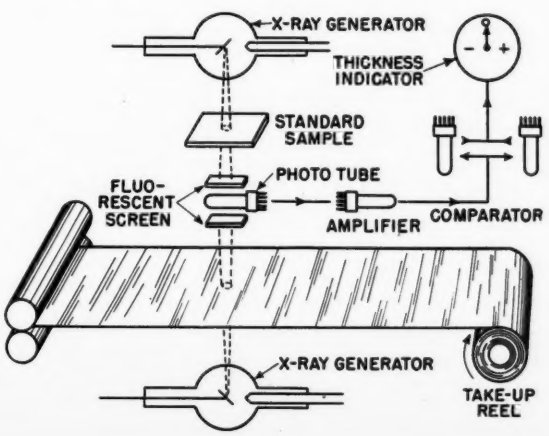
Mechanical Rectifiers

This meeting gave considerable attention to the subject of rectification. Curiously enough, as was pointed out by J. T. Thwaites, who presented a paper at a conference on mechanical rectifiers, ever since George Westinghouse and General Electric had their famous feud over the relative merits of a-c and d-c power systems, we have been trying to convert a-c to d-c. It doesn't seem to make sense, yet there are reasons which fully justify this state of affairs, as every electrical engineer well knows. Yet the problem remains.

Once we generate alternating current, how can we best convert it to direct current, which we broke away from in the first place? Of course, the most obvious way of effecting this conversion is by the use of a motor-generator set or by a rotary converter. This, however, seems rather silly, is costly, requires heavy machinery involving much maintenance, and entails some losses. So, quite early, attempts were made to build "rectifiers" of various kinds. A most obvious solution was some sort of a mechanical switch, operated synchronously with the frequency of the alternating current, but early attempts in this direction showed the futility of doing the job that way.

So other types of rectifiers came

(Continued on page 130)



The X-ray thickness gage used to measure the thickness of a moving steel strip

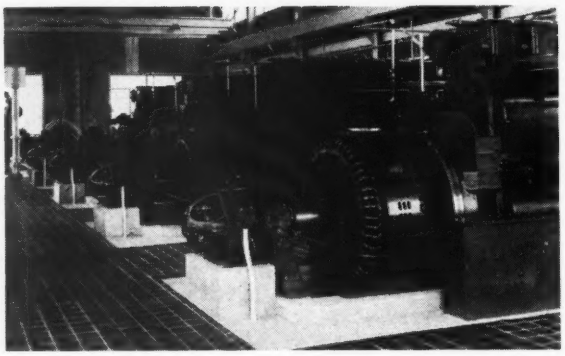


Fig. 1. Four 6-12½-13 American Locomotive Company Diesels designed to deliver 540 bhp at the Aluminum Co. of America plant in Dutch Guiana

What It Cost to Run 10 Diesels for 4 Years

Operation and maintenance cost records of two Diesel power plants located in South America compiled by the engineers in charge of operation. Facts and figures on the cost of plant repairs, replacement parts, fuel oil consumption, and power production. Over a period of 4 years the British Guiana plant expended 0.6 mills per kwhr for replacement parts; the Dutch Guiana plant averaged 0.97 mills over a period of 5 years

IN 1940, five (5) 6-12½-13-T turbocharged Diesel engines, designed to deliver 810 bhp each at 600 rpm, were installed by the Aluminum Co. of Canada for use in their power plant in British Guiana. Five (5) 6-12½-13 Diesel engines, delivering 540 bhp each at 600 rpm, were also installed by the Aluminum Co. of America for installation in one of their plants in Dutch Guiana. The following report is a brief outline of the operating record of the engines installed in British Guiana, and the maintenance record of the engines installed in Dutch Guiana.

The data presented herewith should be of particular interest to Diesel operators in that it represents accurate information on operating and maintenance costs compiled from the actual records of two operating engineers. The records of both plants are well below the national average as recorded in the ASME "Report on Oil Engine Power Cost" for 1943. The Alco engines described above are medium-speed stationary units and are in a size range which makes them adaptable for a variety of demands.

Table I. Description of Diesel power plant in British Guiana and operating and cost data for the years 1942 to 1945, inclusive

COMPARATIVE PERFORMANCE OF DIESEL POWER PLANT IN BRITISH GUIANA 1942, 1943, 1944 AND 1945

DESCRIPTION OF PLANT

Installed diesel engine capacity.....4050 BHP—5 units of 810 BHP
Installed generator capacity.....3125 KVA—5 units of 625 KVA
Capital cost of plant $338,196.09 (B.G.).....$100.88 (B.G.) per installed BHP

OPERATING COSTS

ITEMS	1942 Costs (B.G.)* Per KWH Generated	1942 Costs (B.G.)* Total	1943 Costs (B.G.) Per KWH Generated	1943 Costs (B.G.) Total	1944 Costs (B.G.) Per KWH Generated	1944 Costs (B.G.) Total	1945 Costs (B.G.) Per KWH Generated	1945 Costs (B.G.) Total
Fuel Oil	$0.00886	$ 67,363.93	$0.009444	$ 99,311.77	$0.006354	$ 40,696.45	$0.005638	$35,006.50
Lubricating Oil	0.00094	7,128.97	0.000703	7,391.79	0.000878	5,625.47	0.000656	4,075.59
Operating Labour	0.00120	9,141.28	0.000976	10,258.97	0.001682	10,770.28	0.001754	10,889.88
Repairs and Maintenance	0.00204	15,507.32	0.001319	13,872.89	0.002304	14,748.05	0.001567	9,730.52
Depreciation	0.00459	34,879.02	0.004073	42,829.89	0.005330	34,140.04	0.0049	30,422.22
Miscellaneous	0.00055	4,178.73	0.000490	5,152.93	0.000485	3,107.33	0.000226	1,402.75
TOTAL	$0.01818	$138,199.35	$0.017005	$178,818.24	$0.017033	$109,087.62	$0.014741	$91,527.46

OPERATING DATA

REMARKS	1942	1943	1944	1945
Total engine hours operated	21,896	29,427	17,956	17,082
Total kwhr generated	7,606,100	10,515,660	6,404,800	6,209,000
Total fuel oil consumption (U.S.) gallons	588,925	822,538	509,949	483,048
Total lubricating oil consumption (U.S.) gallons	6,351	6,546	4,763	4,534
Kwh output per gallon (U.S.) of fuel oil	12.92	12.784	12.56	12.646
Kwh output per gallon (U.S.) of lubricating oil	1198	1606	1345	1347
Average cost per gallon (U.S.) of fuel oil	$0.11438 (B.G.)	$0.1207 (B.G.)	$0.0798 (B.G.)	$0.0787 (B.G.)
Average cost per gallon (U.S.) of lubricating oil	$1.1225 (B.G.)	$1.1292 (B.G.)	$1.1811 (B.G.)	$0.8989 (B.G.)
Station running capacity factor		71.0%	71.3%	69.4%

*British Guiana

Table II. Maintenance cost report of Diesels in British Guiana power plant for years 1942 to 1945. Average cost for the 4 years is compared with the National Average as given in ASME "Report on Oil Engine Power Cost for 1943"

ALUMINUM COMANY OF CANADA (POWER PLANT ONLY) PARTS

	1942	1943	1944	1945
Total cost of repairs, parts only	4,520	6404	761	6658
Maint. per kwhr, parts only	0.00059	0.00057	0.000012	0.0010
Kwhr generated in 1000's	7606	10,515	6405	6,209

	4 Year Average	National Average*
Kwhr generated	7,684,000	7,263,000
Maintenance per kwhr	0.059 Mills	1.30 Mills
Cost per hp per year	$1.13	$2.10

*Taken from A.S.M.E. "Report on Oil Engine Power Cost for 1943."

The report from the power plant in British Guiana covers only 86,361 hours of operation for the years 1942 to 1945, inclusive, as no record was available for 1941. Working on the assumption that engine hours were evenly divided, it appears that each engine averaged 4318 operating hours per year, or approximately fifty per cent of the installed time.

Reference to the data tabulated in Table I reveals several facts which justify the purchase of this type of power plant equipment for base load service. First of all, the total cost of all plant repairs averaged 1.75 mills per kwhr. Of this figure approximately one-third is chargeable against the total cost of repair parts for the Diesel engine. Actually, $0.000597, or roughly 0.6 mills, per kwhr was expended for replacement parts, some of which were still included in inventory, but which were already charged off to maintenance cost in the 0.6 mills.

On the basis of dollars per rated horsepower per year, maintenance for all purchased parts comes to only $1.13. Both of these methods of evaluation compare favorably with the national average for slow speed engines of 360 rpm or less as recorded in the ASME "Report on Oil Engine Power Cost" for 1943. In fact, this plant's maintenance cost was roughly one-half the average recorded inside the United States. These data are tabulated in Table II.

The lubricating oil economy of this plant average 2000 horsepower hours per gallon of lube oil. No attempt was made to reclaim used oil; leakage and other usage of lube oil are included in this figure.

The fuel oil consumption of the five engines averaged 12.75 kwhr per gal at an average plant running capacity factory of 70 per cent. This also is an overall record which includes leakage and other plant uses of fuel oil, such as for cleaning service. The load conditions of the plant called for operation at less than half load for approximately 50 per cent of the time, and at full load the other half of the period. This was due to the characteristics of mining operation utilizing large heavy mine hoists and elevators.

A detailed account of the parts renewed on the engines in the plant in Dutch Guiana for the years 1941 to 1945, inclusive, is shown in Table III. While the maximum time operated by any one engine covered by this report is 20,183 hours, the total engine time reported is 94,055 hours.

Reference to Table III reveals that a high bearing replacement was required. It is of interest to know that one engine, No. 2599, used 59.9 per cent of the replacement bearing shells. While there is no apparent explanation for this phenomenon, it is desirable to point this out in fairness to the other engines. After the first two years' operation, a different type lubricating oil was used and bearing replacements declined materially.

Another group of replacements about which a few comments would be of value to the reader is liners and pistons. Five liners were replaced in these engines, a figure which is not considered excessive, but in no case were the replacements made necessary by wear. One liner was damaged when an exhaust valve dropped into the cylinder; the other four were due to cracks at the upper end. The four pistons, with one exception, were replaced to avoid using non-standard parts, i.e., the ring grooves in the aluminum pistons were worn and rather than use extra wide rings, the pistons were replaced. The fourth piston was damaged by the exhaust valve dropping into the cyl-

Table III. Summary of parts renewed from February, 1941, to December, 1945, on four of the Diesels installed at Dutch Guiana plant. Note that engine No. 2599 required 59.5% of the replacement bearing shells.

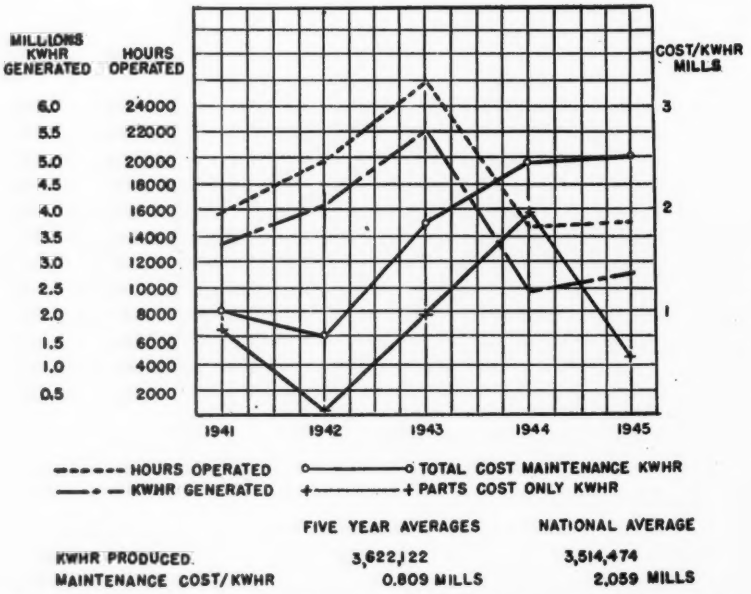
TABLE III

	Total per 4 Engines 79188		Engine No. 2599 19212		Engine No. 2600 20183		Engine No. 2601 19614		Engine No. 2602 20179	
Operating Hours	Top	Bott.	Top	Bott.	Top	Bott.	Top	Bott.	Top	Bott.
Main bearing shells renewed	13	5	4	2	4	1	2	2	3	—
Crankpin bearing shells renewed	16	8	12	7	—	—	4	1	—	—
Thrust bearing shells renewed	1	—	—	—	—	—	1	—	—	—
Thrust bearings renewed	—		—		—		—		—	
Pistons renewed	4		1		1		1		1	
Piston compression rings renewed	71		8		36		18		9	
Piston oil scraper rings renewed	29		4		21		4		—	
Intake valves renewed	—		—		—		—		—	
Intake valve springs renewed	3		1		—		—		2	
Exhaust valves renewed	7		1		—		6		—	
Exhaust valve guides renewed	57		—		24		24		9	
Exhaust valve springs renewed	18		3		5		3		7	
Air starting valves renewed	—		—		—		—		—	
Spray valves renewed	8		—		2		2		4	
Cylinder liners renewed	5		—		1		1		3	
Cylinder heads renewed	1		—		—		1		—	

Table IV. Tabulation of cylinder liner wear on engine No. 2603 after 13,000 hours of operation

ALUMINUM COMPANY OF CANADA Engine No. 2603—American Locomotive 6-12½-13—600 rpm

	1		2		3		4		5		6	
From Top of Ring Travel	Parallel	Across Crankshaft	Parallel	Across Crankshaft	Parallel	Across Crankshaft	Parallel	Across Crankshaft	Parallel	Across Crankshaft	Parallel	Across Crankshaft
½"	12.503	12.504	12.503	12.507	12.505	12.508	12.504	12.510	12.503	12.506	12.504	12.507
3"	0.501	0.503	0.501	0.504	0.502	0.504	0.501	0.505	0.501	0.502	0.502	0.503
6"	0.501	0.502	0.501	0.503	0.501	0.503	0.501	0.504	0.501	0.502	0.501	0.503
12"	0.501	0.502	0.501	0.502	0.501	0.503	0.501	0.504	0.501	0.502	0.501	0.503



	FIVE YEAR AVERAGES	NATIONAL AVERAGE
KWHR PRODUCED.	3,622,122	3,514,474
MAINTENANCE COST/KWHR	0.809 MILLS	2.059 MILLS

Fig. 2. (Above) Chart showing maintenance cost per kwhr, hours operated, and kwhr generated for the 5 Diesels at the Dutch Guiana plant. Table V. (Below) Tabulation of replacement parts and cost for Diesels at Dutch Guiana plant

TABLE V

ALUMINUM COMPANY OF AMERICA

Quan.	Part	Dwg. No.	Unit Price	No. Units	Total
1	Main bearing shells—st'd	14-C-2376-1	$18.60	18	$334.80
1	Main bearing shells—thrust	14-C-2377-1	31.50	1	31.50
1	Main bearing shells—center	14-C-2378-2	22.60		
	NOTE: Upper and lower main bearing shells are identical				
1	Main piston assembly	5-S-420-5	200.00	4	800.00
1	Piston ring	42-D-1524-1	2.60	71	184.60
	Piston ring	42-D-1438-1	2.60		
1	Scraper ring	42-D-1523-1	3.80	29	110.20
1	Main cylinder liner	21-B-2059-1	165.00	5	825.00
1	Main cylinder head	5-C-220-6	260.00	1	260.00
1	Air valve	23-C-49658-5	12.65	0	
1	Exhaust valve	23-C-2034-2	12.65	7	88.55
1	Exh. & air valve spring—large	46-D-2021-1	1.15		
1	Exh. & air valve spring—small	46-D-2022-1	1.75	21	36.75
1	Air valve guide	23-C-49656-1	7.50	57	427.50
1	Exh. valve guide	23-C-49657-1	7.50		
1	Starting valve	23-D-7002-1	17.25		
	Fuel needle & guide (DECO)	23-D-4129-1	26.00	8	208.00
1	Half bushing (for conn. rod & cap)	17-B-3145-1	21.00	24	504.00
		4 Engines, 5 years			$3,810.90
		35c per hp per year			

inder. Table IV gives a tabulation of liner wear on engine No. 2603 taken after 13,000 hours. Inasmuch as maximum liner wear is 0.031 in., and the maximum out-of-round wear is 0.015 in., it can readily be seen that the liners in this engine have used up less than one-third of their life.

The maintenance cost per kwhr for the five engines installed by the Aluminum Co. of America in their plant in Dutch Guiana is shown graphically in Fig. 2, in which hours operated, kwhrs generated, and cost per kwhr, are plotted over a five year period. A tabulation of the parts used and the cost is given in Table V. Over the five year period from 1941 to 1945, inclusive, the average maintenance cost of replacement parts per kwhr for this plant comes to 0.809 mills. This is roughly 40 per cent of the average maintenance cost per kwhr for ten plants of approximately the same size as tabulated in the ASME "Report on Oil Engine Power Cost" for 1943.

Looking at the overall cost of power production by these plants, located in South America, and hence requiring imported fuel, lube oil, parts, and other services at comparably higher prices, conclusive evidence of their fine results can be seen. The total operating cost of the British Guiana plant, including fixed charges, fuel, lube oil, maintenance, attendance, and all other charges, amounts to 1.75 cents per kwhr. On a twenty year amortization plan, this final total cost would run approximately 0.9 to 1.0 cents per kwhr.

TANK INSULATION WITH MINERAL WOOL BOARD

By KENNETH RITCHIE

Chairman, Specications Committee, Industrial Mineral Wool Institute

TO DEMONSTRATE the best method of installing the new board form of mineral wool insulation on tanks, towers and circular vessels, the illustrated model was recently built and photographed in the research labora-

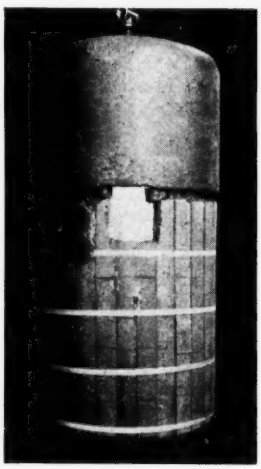


Fig. 1. Insulating cement has been troweled into the crevices between the blocks and over the entire surface and the board has been laid over the entire tank

tories of one of the major mineral wool producers.

The recommendations, based on findings in the lab, are as follows: (1) Remove all dirt, grease, paint, and other extraneous materials from the surface of the tank. (2) Hold the blocks temporarily in place by a rope and spring; by a tacky material such as asphalt; or by cements especially manufactured for the purpose. (3) Install the long dimension of the blocks parallel to the height (or length) of the vessel. Where possible, the joints of each parallel row should be staggered with those of the preceding row. (4) Secure steel bands or reinforcing wires around the circumference of the container to hold the insulation permanently in place. Blocks laid on top of the tank, or on other flat horizontal surfaces, can be secured by wires running with the radii of the surface. (5) Trowel mineral wool insulating cement into the crevices between the blocks and then over the entire surface. (6) Finally finish off the job with a suitable finishing cement.

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Fatigue Cracking of Retaining Ring Causes Turbine Accident

Cracking of rotor retaining ring causes failure of 2000 kw turbo-generator in a textile mill power plant . . . Unit built in 1919 . . . Failure was traced to operation of the machine under unbalanced phase conditions. Like many other accidents this one could have been prevented by proper attention to operating conditions

THE OPERATOR'S FUNCTION in a power plant is to keep the power plant equipment running. This means the prevention of accidental shutdowns and this in turn means knowledge of operating conditions as well as close and continued inspection of all parts of the machinery.

A machine that is improperly operated often is subjected to stresses for which it is not designed and these stresses may in time result in complete failure. In the case described in this article, if the operators had recognized the danger of improper operating conditions it is probable that the accident would never have occurred.

This case involved the cracking of a retaining ring on the coupling end of the rotor of a 2000 kw turbo-alternator in a textile plant in March 1947 resulting in a serious accident to the machine with an estimated repair cost of $25,000.

The Accident

The accident was fully described by the Mutual Boiler Insurance Company of Boston in its Accident Prevention Bulletin. The turbo-alternator had been shut down on the previous Friday evening following a normal work week and was started again on Monday morning, when it was synchronized with 11 water wheel generators at 6:00 am and adjusted to carry a load of 600 kw. At 8:15 am the operator heard a loud report followed by a series of grinding noises and fire issuing from the alternator. He immediately proceeded to the throttle valve, but found that the emergency governor had already tripped, apparently due to the vibration of the machine, shutting off the steam supply. At the same time the lights dimmed and went out, indicating that the line voltage had dropped because of the inability of the already loaded water-wheel generators to feed the fault. This in turn was reflected in reduced exciter voltage, with the resultant loss of excitation for all units. As a consequence, the mill had to shut down. Fortunately normal mill operation was restored in approximately twenty minutes when a reserve 3000 kw unit was pressed into service to replace the unit that failed.

The unit involved was built in 1919 and was of rigid frame type with a laminated rotor (See Fig. 1). It had operated at irregular intervals ever since its installation, depending upon the water supply for the hydraulic units. The turbine was of the mixed pressure type, operating condensing and furnishing steam for mill process through an extraction line. The alternator was operated in parallel with eleven hydraulic units which normally furnished power for the base mill load.

Excitation was provided by a turbine-driven exciter and a motor generator set. The turbine-driven exciter, however, was only used for starting purposes and the motor generator set was in operation at the time of the accident.

A collector ring failure occurred in 1940 and upon investigation the manufacturer's service engineer found that the field winding was grounded. The rotor was rewound at that time and a new steel collector ring assembly was installed, replacing the old copper rings. The machine operated satisfactorily until 1942 when more collector ring trouble developed. A new assembly was installed at that time. New retaining rings were also installed because chips or small semicircular pieces of metal had broken out of the edges of the rings where they fit over the slot wedges. The inner surfaces of these rings where they made contact with the slot wedges were copper plated to reduce the contact resistance. Collector ring trouble was experienced a third time in 1945 and another new collector ring assembly was installed. No further trouble was experienced until the retaining ring failed.

The Damage

When the field retaining ring on the coupling end failed both the stator and field windings were badly damaged as illustrated in Figs. 1 and 2. Both required rewinding. About 3 in. of stator and rotor laminations were twisted and so damaged as to require replacement. The stator frame was cracked in two places making it necessary to fit and bolt steel plate patches over the cracks. The cracks are visible in about the center of Fig. 3. The outer and inner air shields and the stator lamination ring at the turbine end were so badly broken as to require replacement.

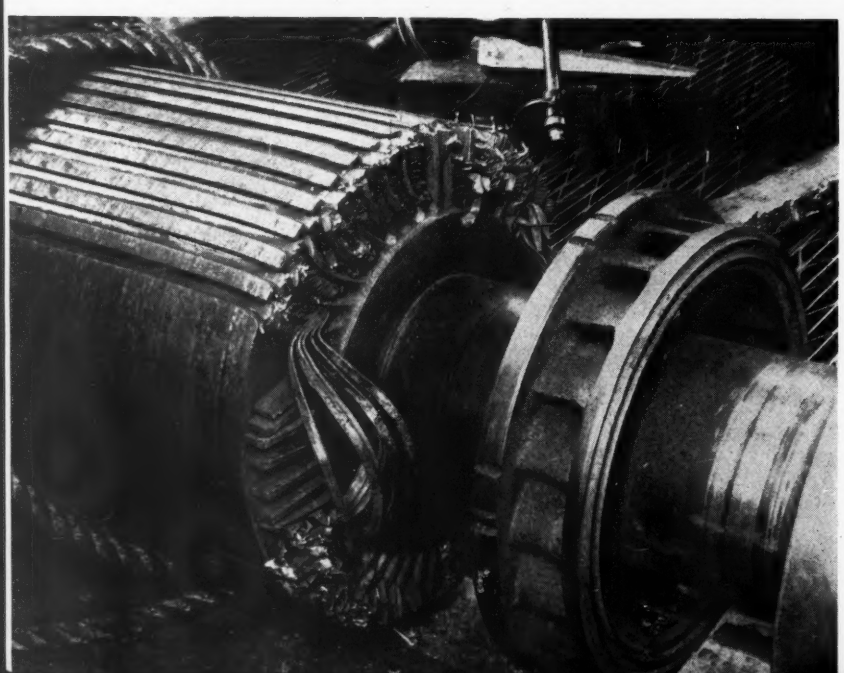
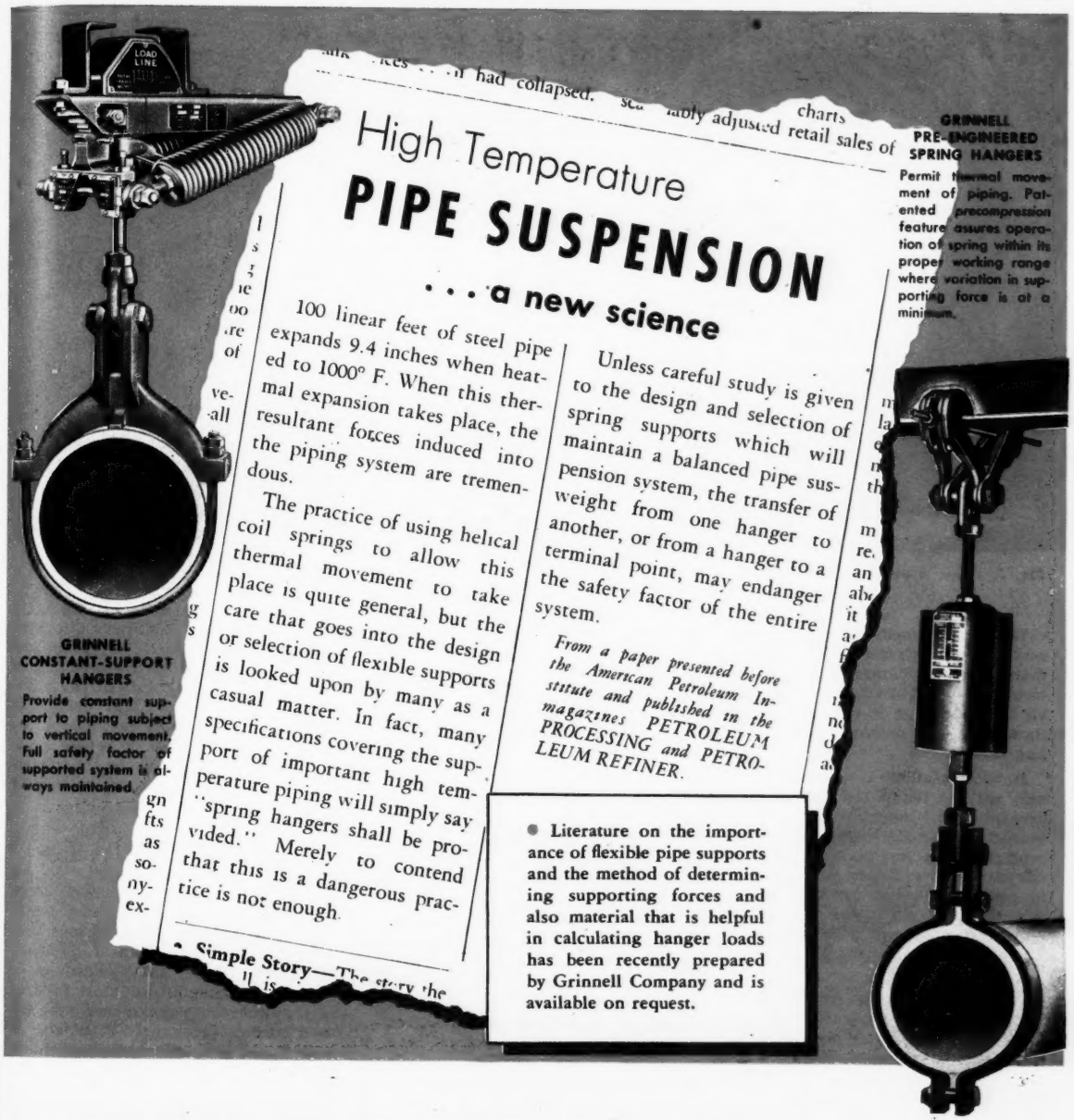


Fig. 1. Rotor, showing the damage to field coils and rotor punchings


had collapsed.
charts
adjusted retail sales of
High Temperature
PIPE SUSPENSION
. . . a new science
100 linear feet of steel pipe expands 9.4 inches when heated to 1000° F. When this thermal expansion takes place, the resultant forces induced into the piping system are tremendous.
The practice of using helical coil springs to allow this thermal movement to take place is quite general, but the care that goes into the design or selection of flexible supports is looked upon by many as a casual matter. In fact, many specifications covering the support of important high temperature piping will simply say "spring hangers shall be provided." Merely to contend that this is a dangerous practice is not enough.
Unless careful study is given to the design and selection of spring supports which will maintain a balanced pipe suspension system, the transfer of weight from one hanger to another, or from a hanger to a terminal point, may endanger the safety factor of the entire system.
From a paper presented before the American Petroleum Institute and published in the magazines PETROLEUM PROCESSING and PETROLEUM REFINER.
Literature on the importance of flexible pipe supports and the method of determining supporting forces and also material that is helpful in calculating hanger loads has been recently prepared by Grinnell Company and is available on request.
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WHENEVER **PIPING** IS INVOLVED

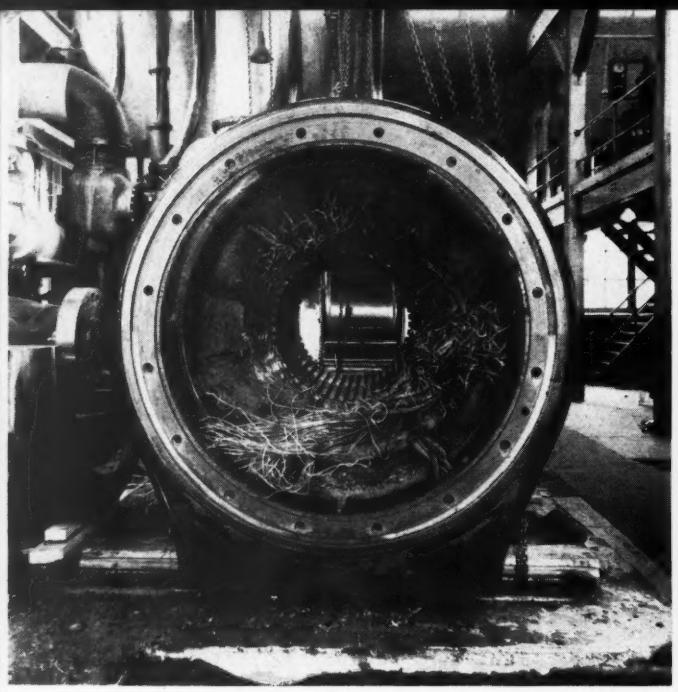

Fig. 2. View showing the damage to the stator winding and stator structure

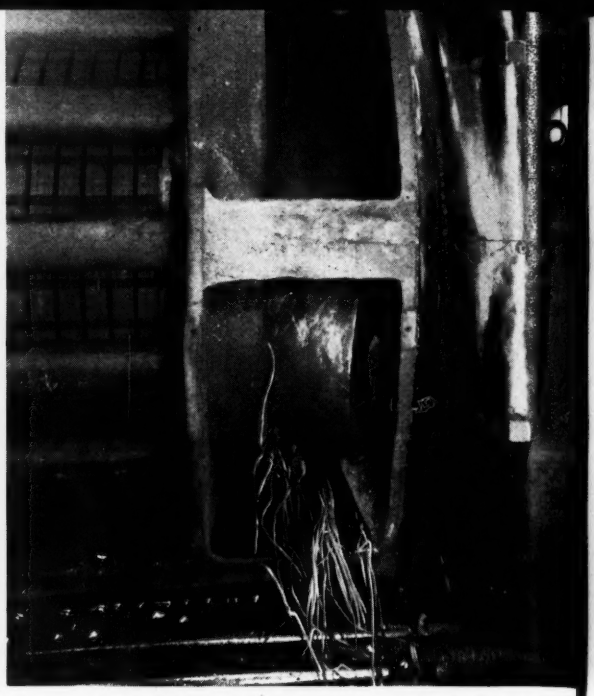

Fig. 3. Turbine end of the alternator frame showing cracks

The owner decided to purchase a new rotor of modern design rather than repair the damaged rotor, which would have required the removal of all the punchings in order to replace those that were damaged at the coupling end.

It will be about a year before the unit will be ready for service again because of the longer periods now required by manufacturers to complete repairs. It is fortunate indeed that the plant had sufficient reserve power to continue normal production since otherwise a prolonged and costly plant shutdown would have occurred.

Inspection revealed that the retaining ring failed initially at the inner edge of the ring adjacent to the coil wedges and that the crack originated where a small chip or piece of metal came out of the edge. Figure 4 is a photograph of the fracture. It will be noted that the smoothest portion of the fractured surface is near the origin of the crack, with the usual progress lines near the center of the ring and the rough surface at the bottom where the final failure took place, all of which is typical of a fatigue crack. This is a characteristic type of failure and the only cause of the condition as far as is known is unbalanced or single phase operation. Several serious accidents have occurred to turbo-alternators with capacity ratings of less than 10,000 kw as a result of this condition.

A study of the operation log in the plant for approximately a year prior to the accident revealed that the alternator had frequently been operated under light loads and low power factor. It was also evident that the machine had been operating with considerable phase unbalance. This unbalance was apparently not due to external loading but was inherent in the machine.

It is characteristic for local heating to take place in the rotor of a 3-phase turbo-alternator operating single phase or under an unbalanced load. When such a generator is operating with all phases balanced, the double frequency component of the armature reaction has no inductive effect on the field and no local heating results. If the alternator phase currents become unbalanced an inductive effect on the field exists as a permanent pulsation of double frequency which is undesirable as it leads to excessive eddy currents in various parts of the rotor, such as the core, slot wedges, windings and retaining rings. The largest currents flow in the circuits of lowest resistance. These eddy currents develop heat which may be high enough to cause burning or a change in the structure of the metal.

This local heating is responsible for the breaking out of semi-circular or elliptical sections from the edge of the retaining ring at the shrink fit or where the edge of the ring covers or butts up against the slot wedges. The arrow on the ring of Figure 5 points to where a small semi-circular piece of metal broke out diametrically opposite from where the ring cracked. Figure 6 is a closeup of the inside of the ring where the piece broke out. The internal surface of the ring as shown in this photograph, magnified approximately four times, appears rough and pitted but such was not the case. The apparent roughness was caused by dirt particles adhering to the oil film. Local heating from unbalanced operation may also cause rapid deterioration of the insulation which ultimately results in a burnout of the coils.

Failures of the kind here discussed have almost without exception occurred as a result of the breaking of retaining rings on rotors of the built-up laminated type. This danger is considerably lessened in modern design through the use of rotors made from solid forgings where the retaining rings usually do not make contact with the wedges or core.

Prevention

Operators of many plants do not fully understand what takes place when an alternator operates under unbalanced load and the serious consequences that may result if operation is continued under such conditions.

The best safeguard against failures of this kind is to make sure that the load current on a turbo-alternator is kept fairly well balanced at all times. Many small power plants lack ade-

Fig. 4. Close-up of fracture in retaining ring

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Water conditioning won't cure a charley horse, that's certain . . . but it *can* reduce the costly problems of scale and corrosion wherever water is used for power, process, or cooling.

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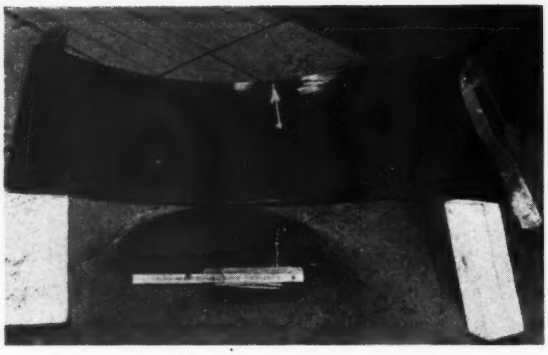


Fig. 5. Broken retaining ring showing where small piece of metal is broken out of lip that fits over the rotor wedges

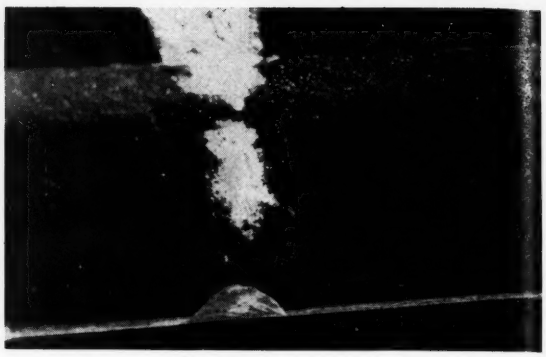


Fig. 6. Close-up of retaining ring lip where piece of metal broke off

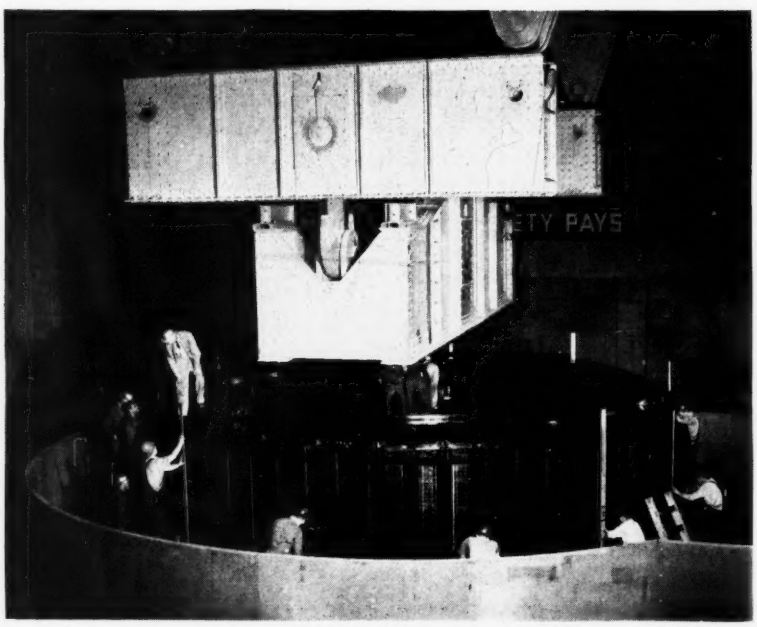
quate metering equipment to properly check balance of phase currents. It is desirable that all installations operating polyphase turbo-alternators be equipped with the metering equipment necessary to check the current in each phase. This can be accomplished by means of one ammeter and a suitable plugging or switching arrangement or by means of ammeters permanently connected in each phase through current transformers. Current readings on all phases should be taken regularly and recorded in the station log. Any appreciable difference in the readings should be thoroughly investigated.

No turbo-alternator should be allowed to operate for any appreciable length of time with a phase unbalance in excess of 10 per cent at full load. The manufacturer should always be consulted as to allowable limits of unbalance for the particular machine under consideration. If it is known that a turbo-alternator has operated for any extended period under abnormal conditions of phase current unbalance or if the unit has been operated single phase even for only a short period of time, the unit should be dismantled so that a thorough inspection can be made of the rotor retaining rings and coil wedges. In fact, every dismantled inspection of a turbo-alternator should include a close examination of the retaining rings by a trained engineer or inspector, particularly the circumferential edges where they come up against or over the slot wedges. Any evidence of localized heating or cracking should be fully investigated. Marks or scratches on the rings which have the appearance of cracks should be examined under a magnifying glass. Pitting, burning or discoloration of rotor laminations and slot wedges, particularly at joints, is another frequent indication of overheating from unbalanced loading. If any cracks or other defects are discovered in the retaining rings it is necessary in most cases to replace the rings on both ends; furthermore, an exhaustive investigation should be made to ascertain if the unit is operating under any unbalance or is subjected to single phase operation at any time.

In this as in all cases accidents can be prevented if they are caught in the early stages of their development. Frequent and proper checking of alternator load conditions together with a close visual examination of retaining rings by competent inspectors will reduce to a minimum the possibility of your turbo-alternator suffering any damage similar to that sustained by the machine described in this article.

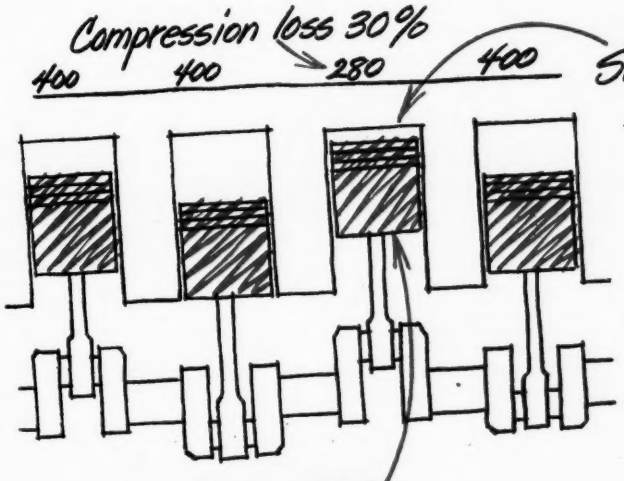
Not an Inch to Spare

THIS WAS a tense moment at the West Powerhouse of the Grand Coulee Dam as a 587-ton rotor for a new generating unit is lowered into place inside the stator, or stationary part. This is Unit L-8, a 108,000-kilowatt giant, which is scheduled to go into commercial production about March 1 to help alleviate power shortages in the Pacific Northwest. Westinghouse Electric Corporation employees hold thin pieces of wood between the rotor and the stator as two big cranes, working as a team, ease the heavy weight into place. There is less than one-inch clearance between the two parts. In the pit behind L-8, workmen are preparing the installation of Unit L-9, final massive generator for the Bureau of Reclamation powerhouse.



LUBE MEMO

Engine overheating caused by stuck rings



Hot blowby gases burned piston.

Shop found rings in #2 badly stuck by ordinary oil (blowby has been wasting power).

Foreman claims RPM DELO Diesel Engine Lubricating Oil's compounds will prevent stuck rings 3 ways:

1. *Decrease carbon*
2. *Stop formation of gum.*
3. *Hold contaminants in suspension (they're flushed out on oil change).*

Give shop go ahead on RPM DELO Oil

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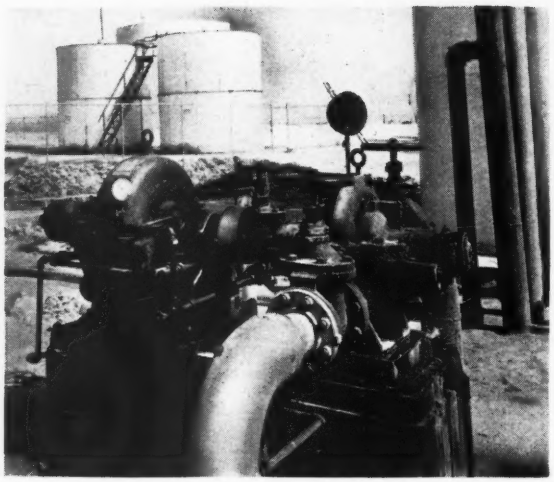


A gas expension turbine driving on oil pump in the Southwest

Power Turbines for Natural Gas Expansion

This application of the mechanical drive turbine uses the available heat and pressure of gas yet leaves the gas intact for burning or processing, and reduces the fire hazard

By **STEPHEN BENCZE**, *Assistant Division Engineer, Turbine Division, Elliott Company*

NATURAL GAS expansion turbines have become an exceedingly important source of power in our gas and oil fields. The low initial cost plus the improved overall efficiency of these turbines, and the fact that no flame or spark is involved, are the main reasons for the popularity enjoyed by this machine. It drives generators, pumps, fans, blowers, and other equipment.

The reciprocating engine is being rapidly replaced in the gas and oil fields by this turbine for the reasons given above. Another reason for this is that the engine burns the gas used for power, whereas the turbine merely uses the energy available from the heat and pressure for driving, and leaves the gas chemically unchanged for further use in processing or as fuel. Still another factor in the turbine's favor is that it can be geared easily, so that the turbine can operate at high speeds while the driven unit operates at low speeds; thus, each operates in its most efficient range.

These turbines differ little in design from ordinary steam turbines and they operate on all kinds of gases. The only requirement is that sufficient energy be available to warrant expansion. Design limitations are governed by the gas used as well as the driven equipment. The gases available are generally at relatively low pressure and temperature, thus usually requiring only the single stage of turbine.

Natural, producer, casing head, etc. gases, are most often used in this turbine. With most gases, no difficulty is encountered that would necessitate special material in the construction. It is only with those containing hydrogen sulphide or other acid forming constituents — usually designated as sour gas, for example, the ordinary run of so-called sour gases from the West Texas and New Mexico fields contain approximately 75 units of hydrogen sulphide—that special construction materials may be needed. If all other operating conditions are favorable even this gas can be used in a turbine of standard steam construction.

When gas pressures and temperatures at the turbine inlet are such that the exhaust temperature drops below 40 F, it is advisable to preheat or raise the temperature of the gas at the turbine inlet. This preheating has been accomplished in many ways. A simple steam jacket around the gas inlet main has been used in cases where the required degree of preheat is small. In other cases, heat exchangers or natural gas fired superheaters have been used.

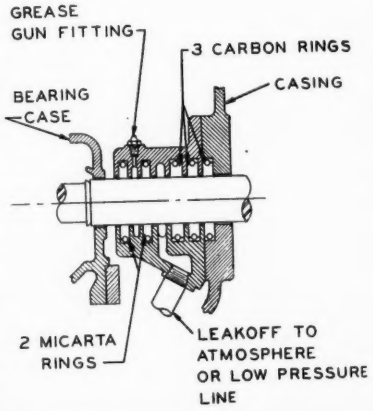
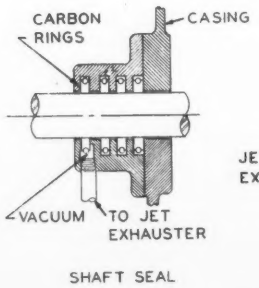
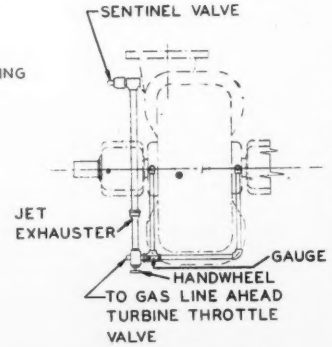


Fig. 2. The carbon rings are of segments with a garter spring retaining them. Grease is packed between the micarta rings forming a grease seal. Leakoff from inner rings is carried to a low-pressure line



SHAFT SEAL



PIPING ARRANGEMENT

Fig. 1. Ejector creates a vacuum, drawing a slight amount of air in past the shaft under the outer ring setting up an air-wall to prevent leakage. The ejector is dischrged to the turbine exhaust if the inlet pressure is sufficiently higher than the exhaust pressure

Because of the fire hazard in the gas and oil fields, particular attention must be paid to turbine seals to prevent leakage. All casing joints must be carefully made and tested at pressures well above operating. Special attention must be paid to leakage past the rotating shaft. Figures 1 and 2 show the usual construction and precautions taken to insure a tight seal. Closer carbon ring clearances are used on the gas turbine than the steam unit because the shaft tends to shrink away from the rings when the unit is running.

Speed control and regulation of gas expansion turbines do not differ from those used for steam turbines.

Thermodynamic efficiencies compa-

A new, low-cost solution to a costly old problem!

HOW TO ASSURE SILICA-FREE WATER FOR HIGH-PRESSURE BOILERS

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Here are three ways by which silica (as well as the other dissolved solids) can be removed from feed water. It will pay you well to make these simple comparisons.

OLD METHODS

Evaporation or distillation at conservative steaming rates is satisfactory but expensive; at high pressures, silica carries over.

Demineralization by sodium fluoride method ... removes silica; but the process involves storing, handling, proportioning, and recovery of dangerous fluorides.

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CYANAMID'S FILT-R-STIL* Demineralizers will produce silica-free, mineral-free water efficiently, at lower cost than either of the old methods, and without the use of fluorides! Cyanamid's process involves no dangerous fluorides or special proportioning equipment. Silica removal is made possible by the IONAC* anion exchanger resin contained in our standard demineralizers. Unlike many anion exchangers, IONAC Resin A-300 can be activated with NaOH rather than Na_2CO_3, without affecting its life in use. This NaOH activation, combined with Cyanamid's systems of demineralization, permits the efficient removal of SiO_2 as well as stronger acids. Water that is directed into a FILT-R-STIL Demineralizer is stripped of essentially all its troublesome silica as well as dissolved ionized solids. *And all this is done quickly, at a new low in cost!*

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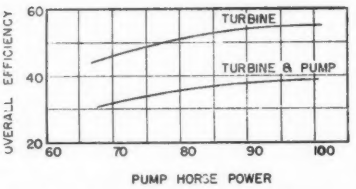

Fig. 3. 100 hp single stage turbine pump drive performance 100 psig inlet pressure, 100 F inlet temperature and 30 psig exhaust pressure with gas having specific gravity of 0.650. Speed at rated horsepower—2750 rpm

rable to those attained with steam turbines can readily be realized. Just as in the case of steam, the performance is dependent upon the available energy in the gas for expansion, the speed and size of the unit, the design of the nozzles and buckets.

The mechanical performance, as to safety and reliability, is proved by the number of units in operation for many years.

Since the usual natural gases are mixtures of so-called permanent gases and behave according to Dalton's Law, the gas mixture may be treated as a single gas with the appropriate physical constants. This concept simplifies calculations and applies accurately to all permanent gases and to all but the heaviest vapors. The necessary constants may be found from the general gas equation pV = wRT. (Editor's Note—Author discussed calculations to greater extent in original at ASME 1947 Spring Meeting at Tulsa, Okla.)

Gas mixtures are generally analyzed on a volumetric basis instead of the weight basis. Weight composition can be readily calculated from the volume composition by using the Mol concept. (A Mol is a volume measure and is equal to a quantity of gas having a weight equal to the molecular weight of the gas.)

$$W_1 = \frac{V_1 \times {}^{m}m^{1}}{V \times {}^{m}m}$$

where: W_1 = weight composition of a gas constituent; V = total gas mixture volume; V_1 = gas constituent volume; ${}^{m}m$ = equivalent molecular weight of gas mixture; ${}^{m}m^{1}$ = equivalent molecular weight of a gas constituent.

Low temperature may be encountered in the expansion of the gas, and if low enough, it might result in condensation or even freezing of water vapor in the gas. It is necessary, therefore, to determine the theoretical temperature resulting from the expansion of the gas. Figure 5 gives a convenient curve for determining the theoretical temperature.

The available energy for power conversion is:

$$\Delta h = \frac{R_m T_1}{778} \frac{n}{n-1}\left[1 - \left(\frac{p_2}{p_1}\right)^{\frac{n-1}{n}}\right]$$

Where: Δh = available energy in Btu per lb; R_m = equivalent gas constant for gas mixture; n = equivalent ratio of specific heats for gas mixture; T_1 = absolute temp. deg F at start of expansion; p_1 = pressure, lb per sq in. abs at start of expansion; p_2 = pressure, lb per sq in. abs at end of expansion.

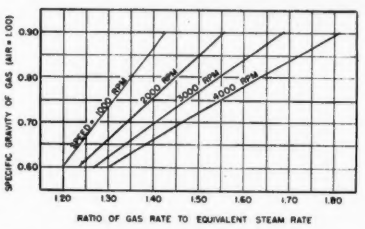

Fig. 4. Comparison of same turbine on natural gas and steam at same temperatures, pressures, and speeds. Gas rates are higher than steam rates mainly because of the difference in available energy. Difference in gas and steam densities and viscosities also raises gas rates

To find the Theoretical Gas Rate for use in determining the volume of gas necessary and horsepower, let E equal efficiency of conversion, then

T.G.R. = Theoretical Gas Rate

$$\text{(lb per hp hr)} = \frac{2545}{E \times \Delta h}$$

The actual weight of gas flow (W) to the turbine, to produce a fixed power (hp), can be determined from

W = lb per hr

$$= \text{T.G.R.}\left(\frac{\text{hp} + \text{losses}}{\text{hp}}\right)$$

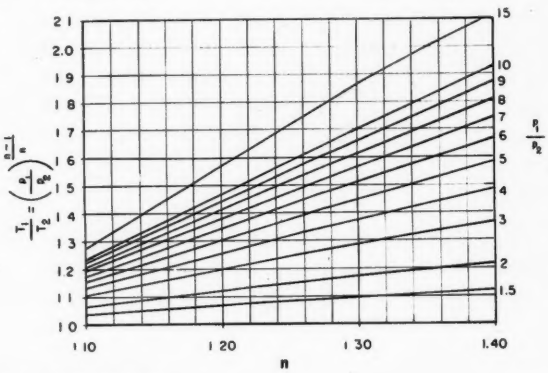

Fig. 5. A convenient curve for determining the theoretical temperature at the end of expansion

Table of physical constants of common gases

Name	Atomic Formula	Molecular Weight	Sp. Gr. (1) (Air = 1.00)	Specific Heat of Vapor (1) c_p	c_v	c_p/c_v	Gas Constant R
Methane	CH_4	16.042	0.554	0.530	0.405	1.309	96.31
Ethane	C_2H_6	30.068	1.038	0.415	0.346	1.198	51.39
Propane	C_3H_8	44.094	1.522	0.376	0.324	1.161	35.03
Iso-Butane	C_4H_{10}	58.120	2.006	0.357	0.312	1.144	26.59
N-Butane	C_4H_{10}	58.120	2.006	0.357	0.312	1.144	26.59
Iso-Pentane	C_5H_{12}	72.146	2.491	— —	0.309	1.121	21.40
N-Pentane	C_5H_{12}	72.146	2.491	0.347	0.309	1.121	21.40
N-Hexane	C_6H_{14}	86.172	2.975	0.339	0.305	1.113	17.92
N-Heptane	C_7H_{16}	100.198	3.459	0.335	0.302	1.109	15.41
N-Octane	C_8H_{18}	114.220	3.944	0.330	0.311	1.060	13.51
N-Nonane	C_9H_{20}	128.250	4.428	0.325	0.310	1.050	12.04
N-Decane	$C_{10}H_{22}$	142.276	4.912	0.321	0.309	1.040	10.85
Ethylene	C_2H_4	28.052	0.985	0.363	0.292	1.240	55.08
Acetylene	C_2H_2	26.036	0.899	0.350	0.270	1.280	59.34
Carbon Monoxide	CO	28.010	0.967	0.248	0.177	1.402	55.14
Carbon Dioxide	CO_2	44.010	1.519	0.197	0.151	1.305	35.09
Hydrogen Sulphide	H_2S	34.076	1.176	0.253	0.192	1.320	45.30
Sulphur Dioxide	SO_2	64.064	2.264	0.154	0.123	1.250	24.10
Ammonia	NH_3	17.032	0.597	0.523	0.399	1.310	90.50
Air		28.966	1.000	0.241	0.171	1.400	53.34
Hydrogen	H_2	2.016	0.069	3.389	2.403	1.409	765.86
Oxygen	O_2	32.000	1.105	0.217	0.155	1.401	48.25
Nitrogen	N_2	28.016	0.967	0.248	0.177	1.404	54.99

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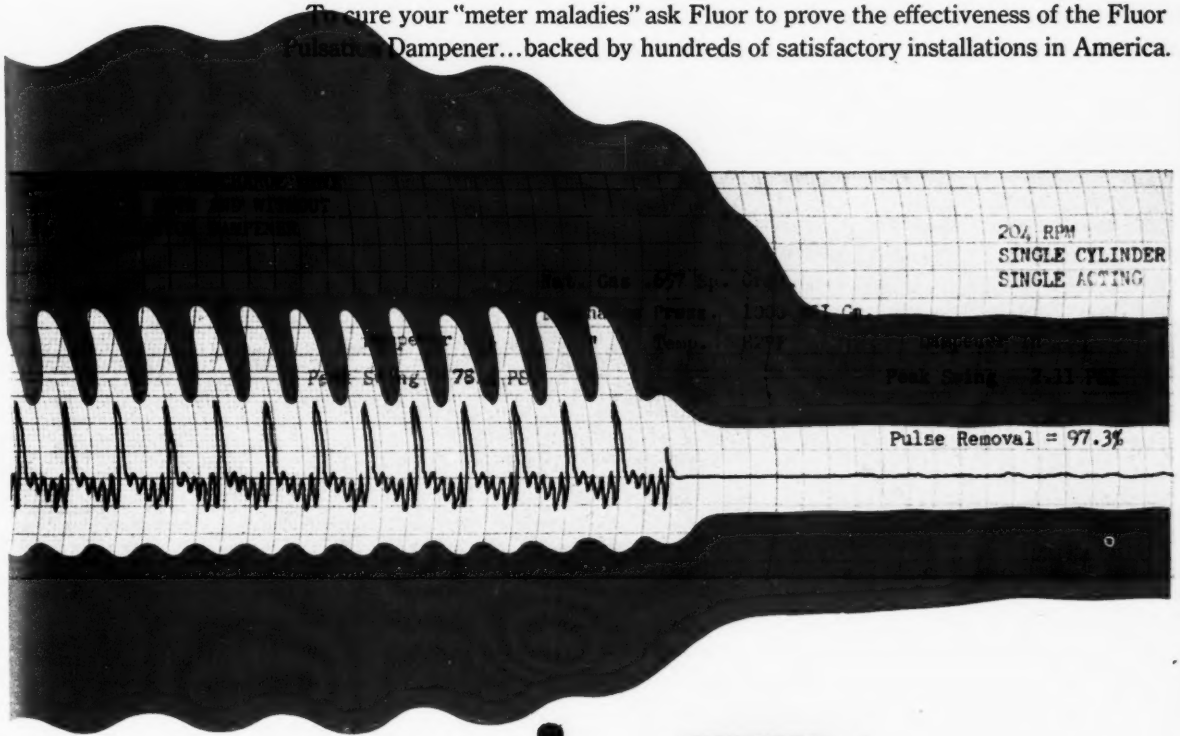

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The Electrogyro—Something New Under the Sun

MOST EVERYBODY concerned with the operation of rotating machinery realizes that a great amount of energy can be stored in a heavy, high speed flywheel; the damage done by failures of flywheels and turbogenerator rotors provide ample testimony to that fact.

Yet, few of us, would think that enough energy could be stored in a comparatively small flywheel to provide a source of power for any length of time. True, a large flywheel will continue to rotate for a long time after the power is shut off but even a moderate braking effect will bring it to rest in a comparatively short time.

In view of these facts a recent development in Switzerland is of considerable interest because it involves a vehicle—a small bus or tram—which is operated from the energy stored in a rotating flywheel. Initially, the flywheel receives its energy from an electric motor, connected to the power lines when the car is stopped but once it is brought up to speed, it proceeds on its way by virtue of the kinetic energy stored in the rotating flywheel.

Electric vehicles have many advantages over those operated by fuel fired engines; they are simple, clean, easy to operate and economical to operate. The fact that they require the presence of an overhead trolley wire, a third rail, or the use of storage batteries is a disadvantage. If it is not economical to install the necessary overhead equipment or if this is undesirable for esthetic or other reasons, and if storage batteries are not capable of supplying a large enough amount of power, the solution of using electric traction with its many advantages cannot be adopted.

As reported in a recent issue of Swiss Technics after investigating the various methods of storing electrical energy feasible for use on vehicles the *Ateliers de Construction Oerlikon, Zurich - Oerlikon* decided about 3 years ago to develop a storage plant using the energy of rotation of a flywheel. A practical solution of this problem was discovered called "Electrogyro" in which the charging and discharging processes are purely electrical.

This Electrogyro has a flywheel of high tensile chrome-nickel steel which is supported by liberally dimensioned ball races in a closed hydrogen-filled container. The squirrel-cage rotor of a three-phase change-pole induction motor is built on to the flywheel, which when connected to a low voltage three-phase supply accelerates the flywheel to approximately 3000 rpm.

This charging process takes place under normal operating conditions in approximately *1 minute*, and can be repeated in practice as often as the service requires. It is, therefore, possible to recharge the storage system at the normal station stops of a vehicle operating to timetable without increasing the station times beyond those normal to-day.

As a result of the arrangement of the flywheel and motor in a totally enclosed housing no stuffing boxes or gas-tight glands are required for the shaft, but it is only necessary to bring in the supply leads to the stationary stator winding through bushings in the enclosure. As a result of the fact that the motor housing is filled with hydrogen, the cooling of the motor is excellent and the windage losses of the group are considerably reduced.

In consequence the running down time of such a gyro-drive unit when the vehicle is stationary is normally about 10-15 hours. It is possible, therefore, to maintain a service having relatively long halts at certain points. While the vehicle is travelling, the motor which is excited by condensers, operates as an asynchronous generator and delivers three-phase current to the traction motors. These last are constructed as squirrel-cage change-pole motors and permit a speed variation of 1 to 5 practically without additional losses in the experimental model.

This model which utilizes an old existing chassis was built to try out the basic principles of the system without taking full advantage of all the available technical possibilities. It operates in a very satisfactory manner and has proved the correctness of all the theoretical calculations made. With a trailer coach the vehicle can travel a distance of 10 to 15 km (approx. 6 to 9 miles) between recharging, which is fully adequate for the distance between stations usual on most transport undertakings.

The sphere of use of the electrogyro vehicle is, therefore, chiefly for services on routes without excessive gradients, and with regular stops not too far apart. It can, therefore, be of use on main line railways, suburban railways, light railways, tramways or motor bus routes. Another important use is for factory and shunting locomotives. For any of these applications it is particularly interesting to note that the circuit developed by the A. C. O. allows direct operation without any modification of the equipment from overhead trolley sections fed with 50 cycle single-phase current.

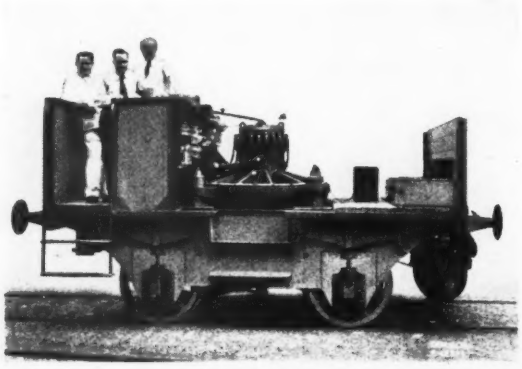
This allows the vehicles to operate at will directly from the overhead trolley or by the energy reserve stored in the electrogyro on sections without overhead trolley.

A gyrotractor could also be usefully constructed for use in mine tunnels either of flameproof construction to avoid fire damp explosions or simply to do away with the use of the overhead trolley which is difficult and dangerous to use in mines.

We must finally refer to the possibility of using the electrogyro for ferries and for boats making local passenger and freight services with frequent regular stops on lakes or rivers.

Apart from the economy realized by using three-phase supply from the existing distribution network, there is the saving resulting from the suppression of the overhead trolley, which is even more valuable if operating or esthetic conditions make its installation undesirable.

The electrogyro is not suitable for heavy traction nor for routes with numerous and steep grades. For standard gage railways, mountain railways, and routes with heavy traffic in large towns, overhead trolley or third rail supply remains, as in the past, the best solution for operating economically and for making available sufficient power where it is required.



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This and other types of Edge Moor boilers are available in a wide range of capacities, pressures and accessory equipment. Write for literature today. EDGE MOOR IRON WORKS, INC. Main Office and Works: Edge Moor, Delaware. Branch Offices and Agents: Atlanta, Boston, Chicago, Detroit, Hoboken, St. Paul, San Antonio and San Francisco.

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COMING EVENTS

ASME—Spring Meeting of the American Society of Mechanical Engineers to be held at New Orleans, La., March 1-4, with headquarters at the St. Charles Hotel.

Stoker—Chicago Stoker Exposition; to be held in Chicago, March 11 to 17, inclusive, at the Commonwealth Edison Association Hall.

Chicago Technical Conference—To be held March 22 to 24 in conjunction with the annual Chicago Production Show, at the Stevens Hotel.

EEI—The 14th Annual Conference of the Edison Electric Institute will be held at the Edgewater Beach Hotel, Chicago, April 6-8.

Midwest Power Conference—Tenth annual Midwest Power Conference; to be held in Chicago April 7, 8 and 9, at the Sheraton Hotel (formerly the Continental Hotel).

ASCE—1948 Spring Meeting of the American Society of Civil Engineers to be held in the William Penn Hotel, Pittsburgh, April 7-9.

ASLE—The American Society of Lubrication Engineers will hold its third Annual Convention at the Hotel Statler, Buffalo, New York, April 19, 20 and 21.

Machine Tool Forum—1948 Machine Tool Forum to be held in Buffalo, April 22-23, at the Hotel Statler.

Refrigeration—Second annual Western Refrigeration Educational Exhibit and Conference; to be held in San Francisco April 30, May 1 and 2, at the Palace Hotel.

Stress Analysis—The Annual Meeting of the Society for Experimental Stress Analysis to be held at the Roosevelt Hotel, Pittsburgh, on May 27, 28 and 29.

Surface Reactions—The Pittsburgh International Conference on Surface Reactions will be held at the Mellon Institute for Industrial Research in Pittsburgh, June 7-11.

ASCE—1948 Summer Convention of the American Society of Civil Engineers to be held in the Olympic Hotel, Seattle, July 21-23.

Instrument Society—Instrument Society of America annual meeting to be held in Convention Hall, Philadelphia, September 13-17.

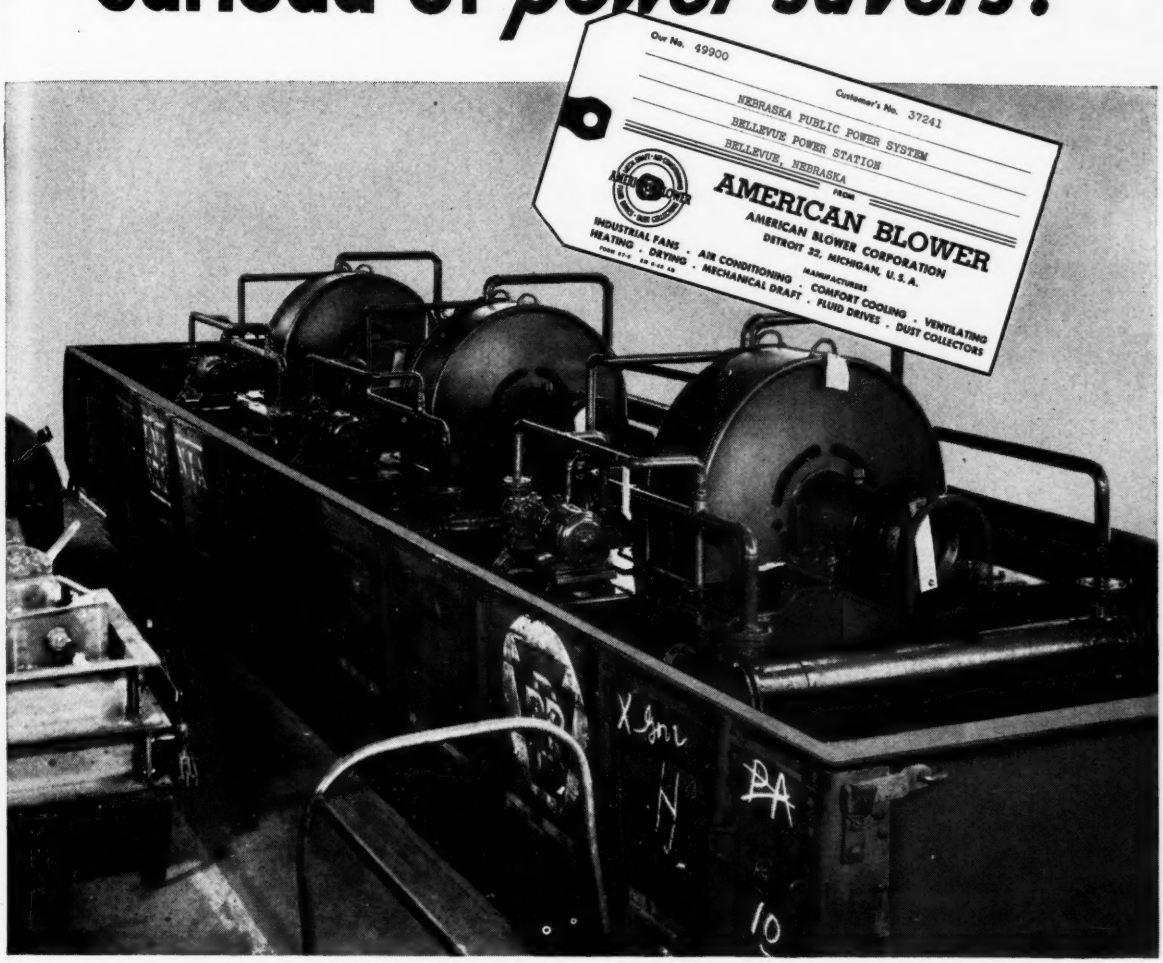
ASCE—1948 Fall Meeting of the American Society of Civil Engineers to be held in the Statler Hotel, Boston, October 13-15.

AIEE—Meetings of the American Institute of Electrical Engineers to be held in 1948 are: Great Lakes District Meeting, Des Moines, Ia., April 1-3. North Eastern District Meeting, New Haven, Conn., April 28-30. Summer General Meeting, Mexico City, Mex., June 21-25. Pacific General Meeting, Spokane, Wash., Aug. 24-27. Middle Eastern District Meeting, Washington, D. C., Oct. 5-7. Midwest General Meeting, Milwaukee, Wis., Oct. 18-22. Southern District Meeting, Birmingham, Ala., Nov. 3-5. No headquarters announced yet.

SUPER LIGHTNING BOLT RECORDED

A SUPER LIGHTNING bolt—believed to be the mightiest ever recorded — struck the University of Pittsburgh's Cathedral of Learning during the 1947 lightning season. Dr. E. L. Harder, in charge of Westinghouse lightning research, disclosing findings of the season's investigations, said the stroke consisted of five separate surges, at least one of which contained an estimated 345,000 amperes of electricity. The supervolt was trapped and recorded on special instruments installed as part of the Westinghouse long-range research program aimed at improving design of equipment to protect homes, factories, and power lines.

Carload of *power savers!*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Heat Recovery Utilizing Flash Steam Regeneration

The heat loss in intermittent boiler blowoff may represent an appreciable value. Calculate the saving which may be made in your plant with continuous blowoff equipment

By M. C. McKEOWN, *Cochrane Corporation, Philadelphia, Pa.*

THE PRIMARY purpose of a continuous blowoff system is to recover heat which would ordinarily be lost when boilers are blown directly to the sewer. In a system employing the "flash" principle, heat is recovered in two stages:

1. By the utilization of steam flashed from the blowoff.
2. By directing the hot waste water remaining after flash through a heat exchanger.

The amount of blowoff required is, in most instances, determined by the permissible concentration of total solids in the boiler water. The accompanying table of general limits in the permissible concentration of boiler water is recommended by the American Boiler Manufacturing Association and Affiliated Industries.

Boiler Pressure psi	Total Solids ppm
0- 300	3500
301- 450	3000
451- 600	2500
601- 750	2000
751- 900	1500
901-1000	1250
1001-1500	1000

In order to demonstrate the procedure used in determining heat recovery and savings, the following conditions will be assumed:

1. One 500-hp boiler operating at 250 psig with an evaporation rate of 15,000 lb per hr.
2. Makeup water (100 per cent containing 171 ppm, or 10 grains per gallon, total solids.
3. Temperature of makeup is 60 F.
4. Pressure of flash tank operation is 5 psi.

Step 1—Calculate Per Cent Blowoff Required

The boiler pressure is 250 psi, therefore, the maximum allowable concentration of total solids is 3500 ppm (approximately 200 gr per gal). Hence for every 20 gal of water delivered to the boiler, one gal of concentrated water should be removed.

$$\frac{\text{Total dissolved solids in feedwater}}{\text{Permissible total solids in boiler}} \times \text{per cent makeup} = \text{blowoff}$$

$$\frac{10 \text{ grs per gal}}{200 \text{ grs per gal}} \times 100\% \text{ makeup} = 5 \text{ per cent blowoff}$$

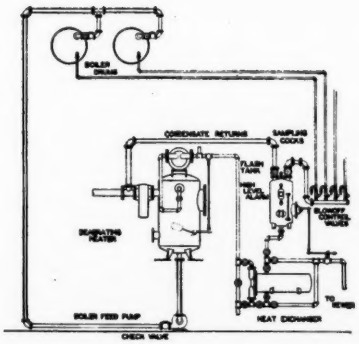


Diagram indicating relation of boiler-room equipment to flash tank and heat exchanger, under conditions assumed for the installation described in the text

Step 2—Calculate Quantity of Feedwater Per Hour

Since evaporation is carried on at a rate of 15,000 lb per hr and the blowoff rate has been calculated as 5 per cent of feedwater, the quantity of feedwater is determined as follows:

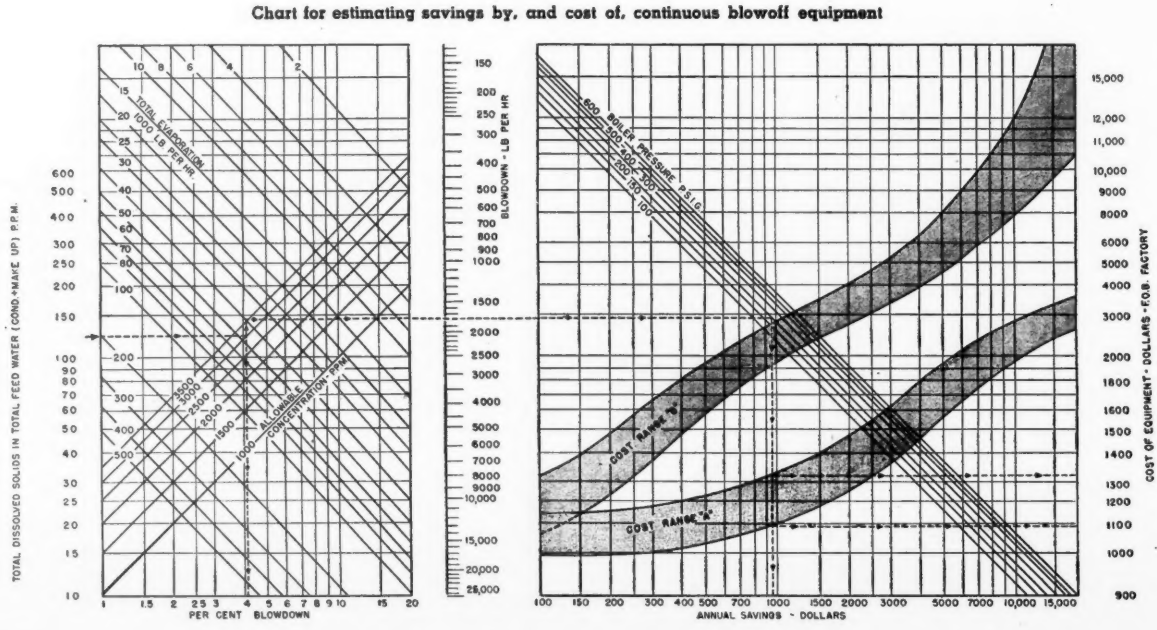
$$\frac{\text{Evaporation lb per hr}}{\text{Evaporation (in per cent of feedwater} = \text{feedwater required.}}$$

In this case, since the blowoff rate is 5 per cent of the feedwater, that remaining for evaporation will be 95 per cent of the feedwater, thus:

$$\frac{15{,}000 \text{ lb per hr}}{0.95} = 15{,}800 \text{ lb per hr}$$

Feedwater, 100 per cent = 15,000 lb per hr
Evaporation, 95 per cent = 15,000 lb per hr
Blowoff, 5 per cent = 800 lb per hr

Chart for estimating savings by, and cost of, continuous blowoff equipment


TOTAL DISSOLVED SOLIDS IN TOTAL FEED WATER (COND.+MAKE UP) P.P.M.
TOTAL EVAPORATION 1000 LB PER HR.
ALLOWABLE CONCENTRATION - P.P.M.
BLOWDOWN - LB PER HR
PER CENT BLOWDOWN
BOILER PRESSURE P.S.I.G.
COST RANGE "B"
COST RANGE "A"
ANNUAL SAVINGS - DOLLARS
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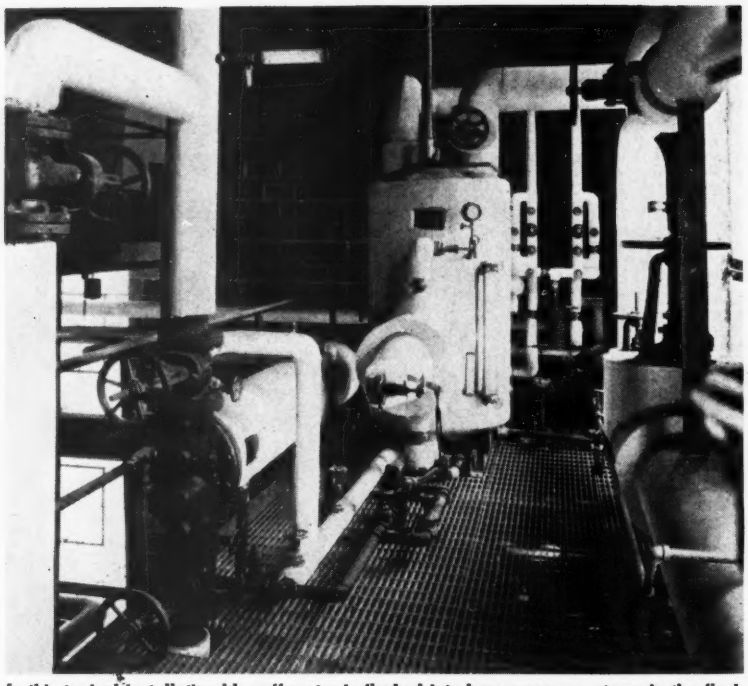


In this typical installation blowoff water is flashed into lower pressure steam in the flash tank, center. Remaining blowoff water passes through heat exchanger, at left, in which heat is transferred to incoming feedwater

STEP 3—CALCULATE PER CENT OF STEAM FLASHED FROM BLOWOFF

$$\frac{\text{Heat of liquid at boiler pressure} - \text{Heat of liquid as flash pressure}}{\text{Latent heat of steam at flash pressure}} \times 100 \text{ per cent} = \text{per cent steam flashed}$$

Using steam tables to obtain the values for Btu and latent heat:

$$\frac{381.6 - 196.1}{959.9} \times 100$$

$= 19.4$ per steam flashed

19.4 per cent of 800 lb per hr blowoff = 155 lb per hr steam flashed.

800 lb per hr blowoff — 155 lb per hr steam = 645 lb per hr water to heat exchanger.

The steam (155 lb per hr) leaves the flash tank and enters the exhaust main.

The water (645 lb per hr at 227 F) is drained from the flash tank and directed through a heat exchanger.

STEP 4—CALCULATE AMOUNT OF COOLING WATER THROUGH HEAT EXCHANGER

In heating makeup water to the temperature of the feedwater heater, approximately 15 per cent of exhaust steam will be condensed. The cold makeup will, therefore, be 13,400 lb per hr to which is added sufficient condensed steam during the heating process, so that the boiler feed totals the required 15,800 lb per hr.

STEP 5—CALCULATE THE TEMPERATURE RISE ON THE COOLING WATER SIDE OF THE HEAT EXCHANGER

Assume a terminal difference of 15 F. This means that the blowoff water will go to sewer at 75 F (15 F higher than incoming cooling water).

$$\frac{\text{Blowoff lbp er hr} \times \text{Temp. drop}}{\text{Cooling Water lb per hr}} = \text{Temperature rise}$$

$$\frac{645 \text{ lb per hr} \times (227 \text{ F} - 75 \text{ F})}{13{,}400 \text{ lb per hr}} = 7.3 \text{ F.}$$

STEP 6—SAVINGS

The Btu saving is equal to the total heat in the boiler water in excess of the heat content of the cooling water available, if there were no terminal difference in the heat exchanger. However, the terminal difference does represent a waste of heat and must be taken into consideration.

$$\text{Blowoff lb per hr} \times \{\text{heat in liquid at boiler pressure}\} - \{\text{heat in liquid of incoming makeup}\} - \{\text{hot blowoff water heat exchanger lb per hr}\} \times \{\text{terminal difference of heat exchanger}\} = \text{Btu per hr saved.}$$

Substituting:

$800\ (381.6 - 28) - (645 \times 15) = 273{,}205$ Btu per hr saved.

Editor's Note: To determine the actual dollar savings and for a complete discussion of this system we refer the reader to "Continuous Blowoff for Boiler Plants" in the February, 1946, issue of POWER PLANT ENGINEERING.

GERMAN D-C AMPLIFIER

A D-C AMPLIFIER CONTROL DEVICE of high industrial value because of its reliable operation under severe mechanical conditions which was developed in Germany is described in detail in a report now on sale by the Office of Technical Services, Department of Commerce. The apparatus has an over-all sensitivity of some 10^{-17} watts and can deliver a substantially larger amount of power to various control devices than a suspended coil galvanometer. The report was prepared by OTS investigator R. A. Goodman.

Work on the amplifier began in 1939 under Dr. Schwenkhagen, director of the Ernst Orlich Institute for High Frequency Research at Wolfersdorf. It was hoped to produce a device at least as sensitive as a suspended coil galvanometer and also free from the inherent defects of a delicate moving system. The device was to be capable of delivering a fairly large amount of power to robust switch gear, indicators, or recorders.

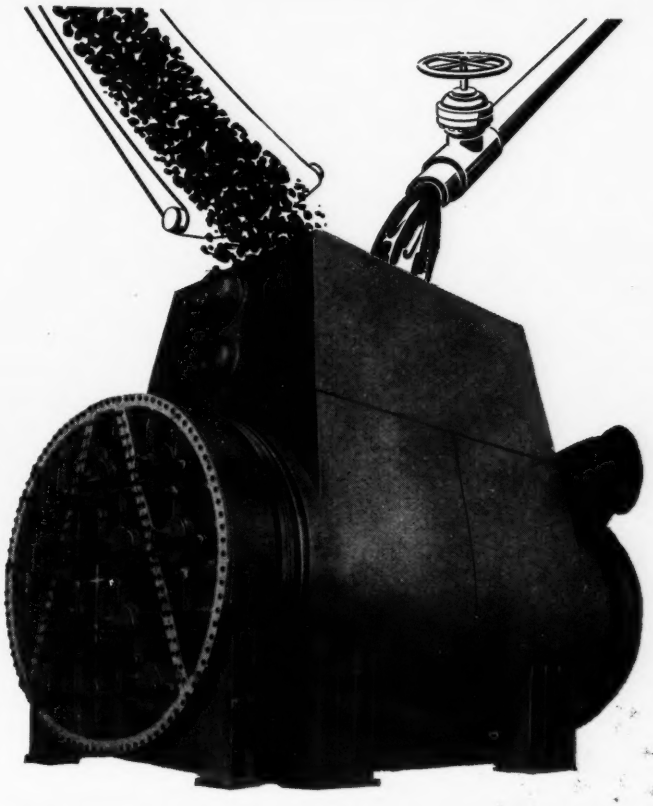
The requirements were successfully met. A model was put to laboratory use in 1941. Subsequent development and manufacture were directed to meet the needs of the German armed forces.

There were two forms of the instrument which differed in the design of the output stage but held in common the principle of applying the d-c signal under test to the primary winding of a transformer through an interrupter or chopper to derive a pulsating signal from the secondary winding. Though this principle is not new, the report states, the researchers did interesting work on the problems associated with input circuit design and the use of compensating feedback for null observations.

Of the two forms of the instrument the one developed first was called a "control converter". As described in the report, the input circuit consists of a coil in series with a breaker. When the breaker suddenly opens its contacts, the energy stored in the magnetic field of the coil gives rise to transient oscillations of the tension across the coil. These tensions either immediately or after amplification are applied to the grid of a gas filled triode (thyraton), the plate of which is connected to the a-c supply. The peak of the transient oscillations ignites the discharge of the triode allowing a flow of plate current until the next zero value occurs. Opening of the breaker and flow of anode current (as long as the peak is high enough) are repeated at 50 cycles per second.

The thyratons proved troublesome for some applications and a second form was developed with vacuum triode input tubes displacing the thyratons. This form, called a "measuring converter," had a continuous output characteristic and was more stable and had greater sensitivity under field conditions.

HOW MUCH FUEL DO YOUR CONDENSERS "BURN"?



Sounds like a foolish question, doesn't it? Actually it isn't—here's why: Every fraction of an inch of condenser back-pressure uses up fuel which costs you money but gives you no return, so in effect that fuel is burned up in the condenser and goes to waste—a total, and often unnecessary, loss.

The loss is unnecessary because condenser back-pressure is the result of lowered heat transfer and most transfer difficulties are due to micro-biological slime deposits on water-side surfaces.

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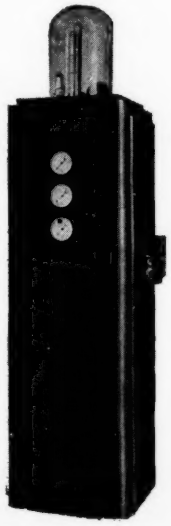

Whether you use fresh, salt or brackish water and regardless of the type of cooling-water system, W&T Engineers with over thirty years' experience in water treatment will be able to show you a job-engineered W&T De-Sliming System for your plant that can save you money—often enough to pay for itself in less than a year on fuel savings alone. Why not call for an engineering study? No obligation, of course.

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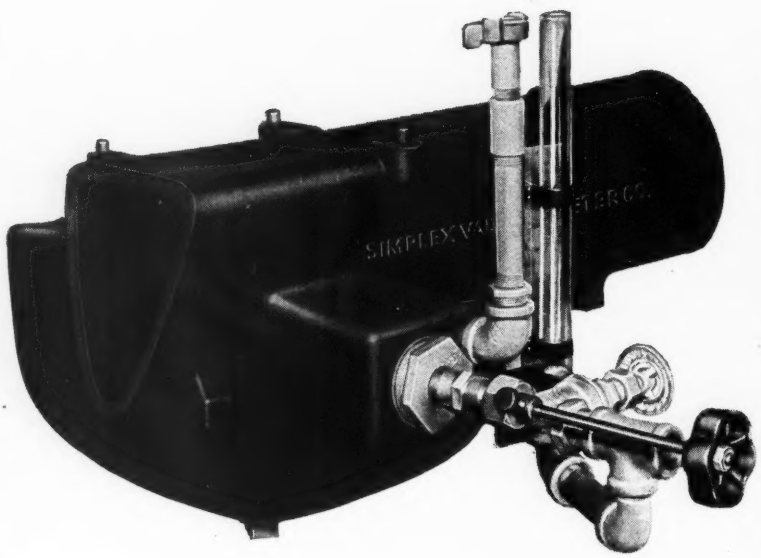

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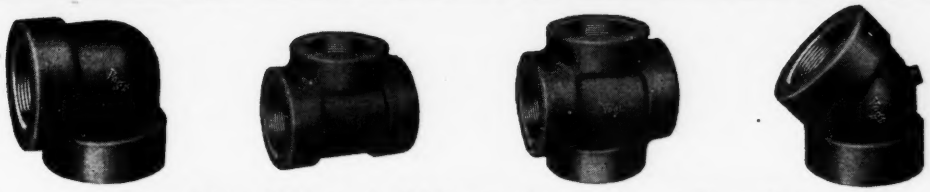

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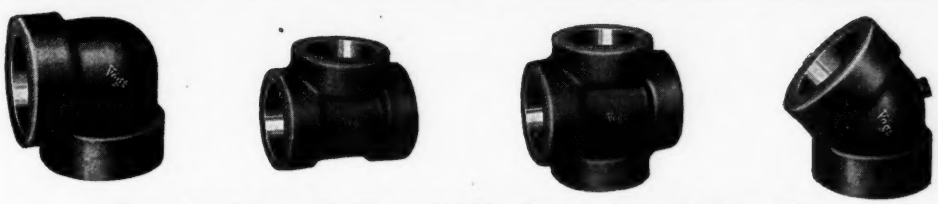

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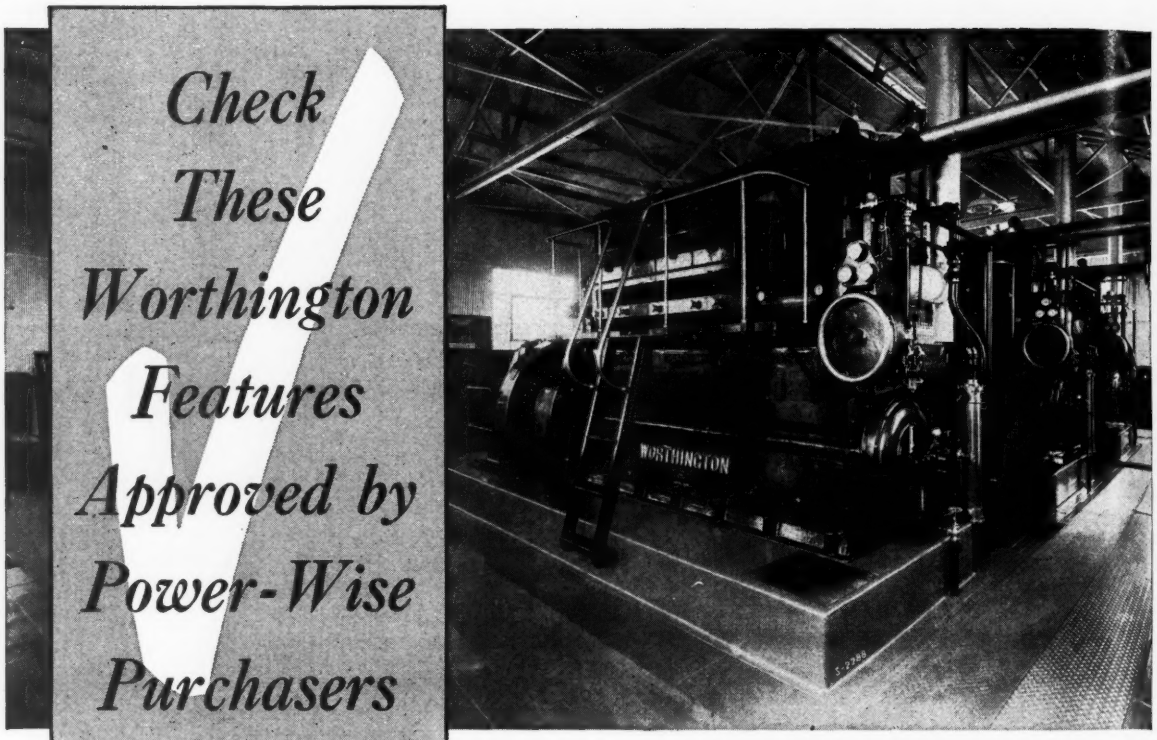

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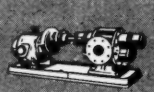

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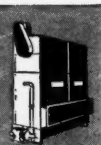

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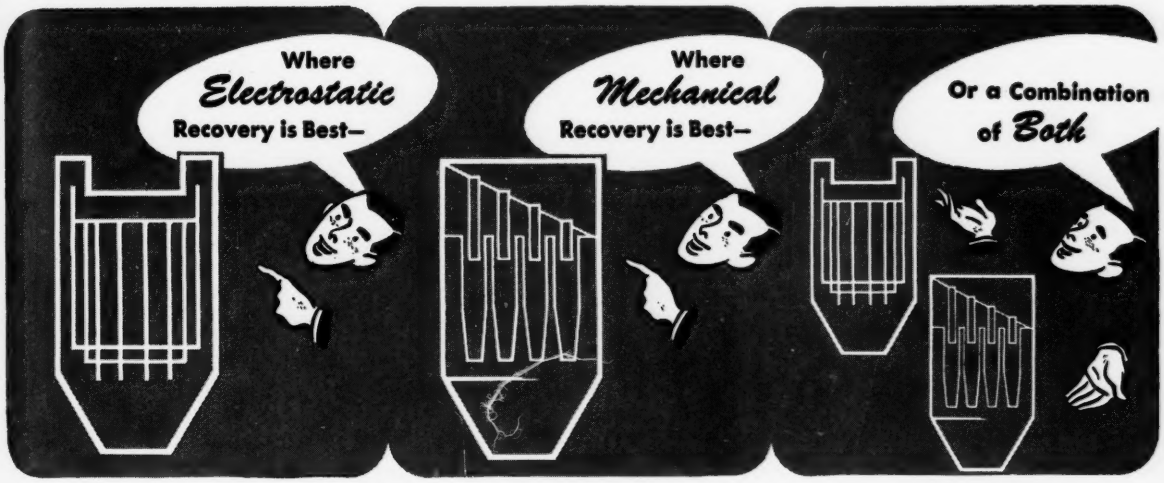

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protects steel stacks from corrosion. Insulating properties improve efficiency.

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resists attack of sulphurous gases and corrosive condensate formed in intermittent and low-temperature operation.

LUMNITE
for Castable Refractories
for jointless walls and arches, baffles, burner blocks, door linings, stoker settings and general refractory purposes.

LUMNITE
for Overnight Structural Concrete
for rapid maintenance. Full strength concrete in 24 hours or less, even in freezing weather.

...give Power Plant Operators these 4 advantages

1. Ease of installation. LUMNITE concrete linings are cast in place to exact shape and size required. For thin sections, as in flues and stacks, linings are shot on with a cement gun or plastered by hand.

2. Jointless Construction. Smoother surfaces result from monolithic, one-piece construction. Absence of joints means less resistance to flow of gases, less wear on linings subject to abrasion.

3. Resistance to heat, corrosion, abrasion. With aggregate selected according to service requirements, LUMNITE makes concrete to withstand high temperature, sulphurous flue gas and fly ash, or corrosion from bunkered coal and cinders.

4. Rapid maintenance work. LUMNITE linings are ready for service 24 hours after placing. Maintenance jobs finished overnight reduce outage time.

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UNIVERSAL ATLAS CEMENT COMPANY
UNITED STATES STEEL CORPORATION SUBSIDIARY
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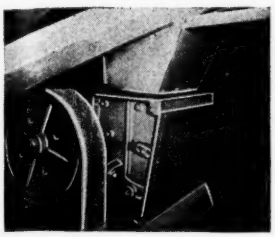
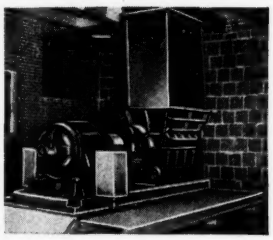
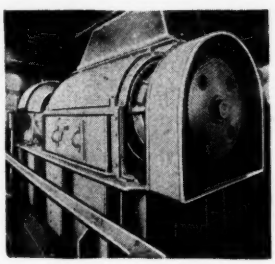
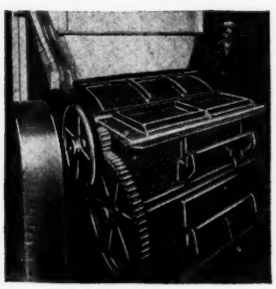
"THE THEATRE GUILD ON THE AIR"—Sponsored by U.S. Steel—Sunday Evenings—ABC Network

THERE'S ROOM IN YOUR PLANT for A COMPLETE CRUSHING OPERATION





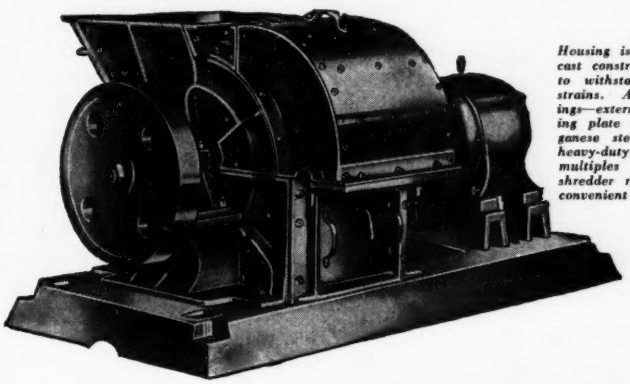




The Compactness of American Rolling Ring Crushers Require Only Minimum Headroom

Designed and built for minimum headroom requirements, the American Rolling Ring Crusher is a compact, high capacity, complete crushing unit that requires no auxiliary equipment and no extra operational or stand-by maintenance labor is required. There is no refuse disposal or extra-picking problem in an American installation.

American Rolling Ring Crushers assure a complete, high-capacity, extremely low-cost crushing operation, uniformly reducing ROM coal to stoker or pulverizer size—handling waste —and rejecting tramp metal for complete safety to mechanical firing devices.



Housing is of massive, high test cast construction — rib-reinforced to withstand enormous crushing strains. Anti-friction type bearings—externally adjustable grinding plate and grate bars. Manganese steel crushing parts and heavy-duty rotor, equipped with multiples of manganese steel shredder rings. Metal trap with convenient clean-out.

Throughout the country in the many power plants with American installations, you'll find efficient coal crushing resulting in efficient firing.

American Rolling Ring Crushers with their patented shredder ring action which *splits coal instead of crushing it* assures uniform sizing. Fines are controlled to a minimum and no oversized is passed. The crushed product is a constant yield of stoker or pulverizer size. The total operating cost of Americans is less than 1¢ per ton. Capacities up to 500 TPH.

Send for bulletin,

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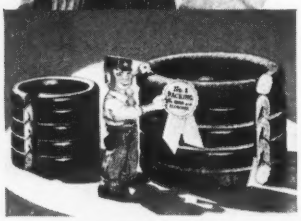

FOR RECIPROCATING SERVICE

J-M Sea Rings are made to give years of service without replacement. They automatically seal on the work stroke, release on the return, reducing friction to a minimum. Use them on smooth rods ¾" O.D. up, in packing spaces 5/16" wide and up.

FOR CENTRIFUGAL SERVICE

J-M Centripac makes a tight seal with minimum friction. Plaited square, it forms a broad bearing surface on rotating and oscillating rods. Recommended for use on centrifugal pumps handling water, brine, ammonia, oil, gasoline, weak acids, chemicals.

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J-M Mogul remains permanently soft and resilient . . . seals without binding . . . assures long, economical service on valve stems and reciprocating rods with small packing spaces. For water, oil, air, ammonia and similar fluids. For gummy fluids, use J-M Jewett.

FOR FLANGE SERVICE

J-M Service Sheet has long been industry's standard gasketing material for high pressure and temperature applications because it is uniform in composition, density, strength, thickness and resiliency. For special applications, J-M furnishes a variety of sheet packings made from 13 basic materials.

FOR ANY SERVICE. Whatever your requirements, Johns-Manville can furnish a packing correctly designed for the service. See your local J-M Distributor or write Johns-Manville, Box 290, New York 16, N. Y., for your copy of the J-M Packing Catalog.

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Johns-Manville

PACKINGS & GASKETS

Obituaries

DR. AUGUST C. KLEIN

DR. AUGUST C. KLEIN, Vice President and Engineering Manager of Stone & Webster Engineering Corp., died February 3, due to a cororary thrombosis while on vacation in Montego Bay, Jamaica, B. W. I.

Doctor Klein was born in Jersey City, New Jersey, April 1, 1887, the son of August Klein and Louise (Gavenesch) Klein. He was graduated with the degree of M. E. from Stevens Institute of Technology in 1908. He has been continuously engaged in engineering work since that time except for his service in the Ordnance Department of the United States Army during World War I when he held the rank of First Lieutenant and was assigned to the production of toluol and nitrates for the armed services. Prior to the war, Doctor Klein was a gas engineer for United Gas Improvement Co. in Philadelphia and after his return from military service became a gas engineer with Stone & Webster

Engineering Corp. in its Boston office. Subsequently he enlarged his field of activity to include the design of steam power plants and chemical plants and acquired a national reputation as an authority on depreciation and public utility rates.

In 1929 he became Chief Mechanical Engineer of Stone & Webster Engineering Corp. and during World War II he was detached from other work of this organization to take charge of several TNT plants being built for the United States Army. In 1942 he became Project Engineer on the Stone & Webster work for the Manhattan Project. During this period he supervised the engineering design of the first atomic pile at the Argonne Forest Laboratory of the University of Chicago and the great electromagnetic uranium separation plant at Oak Ridge, Tennessee. Incidental to this work, he was in charge of the layout and design of the city which bears that name.

In 1945 he became Engineering Manager of Stone & Webster Engineering Corp., and a year later was elected Vice President. In recognition of his outstanding service to the success of the atomic bomb project, he was awarded a degree of Doctor of Science by Stevens Institute of Technology in February, 1947.

Doctor Klein was a Fellow of the American Society of Mechanical Engineers, a charter member of the American Gas Association, and a member of the Massachusetts Society of Professional Engineers and

the National Society of Professional Engineers. He was a member and Governor of the University Club, a member of the Algonquin Club, the Skating Club of Boston and the Stone Horse Yacht Club of Harwichport. He has contributed numerous articles to professional journals.

Doctor Klein is survived by his wife, Maree Stone (Keeling) Klein, four sons, James H., Frederick W., August S., John D., and a daughter, Maree L., all residing at 21 Gray Cliff Road, Newton Center, Massachusetts. He is also survived by a brother, Elmer Klein of Rutherford, New Jersey, and by two sisters, Madeline Walsh of Arlington, New Jersey, and Mrs. Lillian Brandenburg of Barnsboro, New Jersey.

THORLEIF THORSTEN

THORLEIF THORSTEN, Chief Mechanical Consulting Engineer for West Penn Power Co. and The West Penn Electric Co., died recently at West Penn Hospital, Pittsburgh.

Mr. Thorsten was born in Hamar, Norway, and graduated from Oslo Technical College with a degree in Mechanical Engineering. From 1900 to 1905 he was a designer of steam locomotives in Norway. The following year he came to the United State as a mechanical engineer with the American Locomotive Co. at Schenectady, New York.

In 1907, Mr. Thorsten accepted the same position with the Virginian Railway Co., Norfolk, Virginia. He also was affiliated with the Babcock and Wilcox Co. of Bayonne, New Jersey. From 1910 to 1915 he was with Sargeant and Lundy, Consulting Engineers in Chicago, and represented them as Supervising Engineer during the installation of the units and boilers at West Penn's Connellsville Station.

As West Penn's Chief Mechanical Engineer, Mr. Thorsten designed mechanical equipment in the Springdale and Windsor Stations, and the Springdale and Windsor Mines. He was the designer and builder of West Penn's Connellsville Storeroom and Laboratory; Greensburg Terminal and Freight Station; Uniontown Terminal; Storerooms, Garages and other West Penn Buildings. Recently, he had worked on plans for the company's new Mitchell Power Station now under construction on the Monongahela River near Courtney.

Mr. Thorsten was a member of the Longue Vue Club, the Engineers Society of Western Pennsylvania, and the Shadyside Presbyterian Church. Surviving are his wife, Mrs. Marie Eeg Thorsten; a son, Leif E., and a daughter, Sigrid Marie, all of Pittsburgh.

WALTER H. WOOD

WALTER H. WOOD, service engineer with Combustion Engineering Co., Inc., died suddenly of a heart attack at Piqua, O., recently.

Born in Fayetteville, Ark., October 7, 1875, Mr. Wood received his technical education at the University of Arkansas, and following graduation became associated with his brother, Albert C. Wood, consulting engineer of Philadelphia, for a period of 14 years. Two years were spent as combustion engineer with the American Writing Paper Co. and a year in charge of stationary power plants of the B. & O. Railroad. In March, 1917, he joined Combustion Engineering Co. where he organized and became head of its test department. He remained in that work until 1931, when he was transferred to service engineering, where his extensive field work brought him in contact with the operating personnel of many installations in the United States, as well as South America and Canada.

It may be recalled that he was the author of numerous papers and articles dealing with testing and with operation of traveling-grate stokers, subjects upon which he was regarded as an authority. Surviving are his wife and one son.

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WHEN you need industrial packing, you generally need it in a hurry.

Located conveniently near you is a distributor who maintains a wide and varied stock of Johns-Manville Packings.

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Put Power Equipment Back in Production Quicker, at Lower Cost

Study these views of broken and cracked frames and crankshaft. They will give you an idea of the big savings in time and money Metalock casting repair service is delivering in plants all over the country . . . Metalock repairs, made only by workmen thoroughly trained in this patented process, have been proved and accepted by manufacturers, users, underwriters.

STEAM ENGINE FRAME

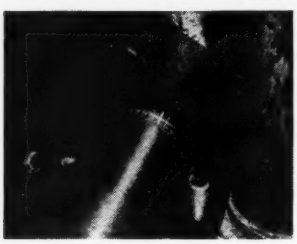
Before

After

20 IN. DIESEL CRANKSHAFT

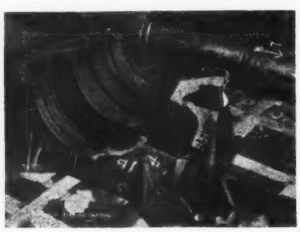
Before

After



PLUMMER BEARING (Navy Photograph)

Before



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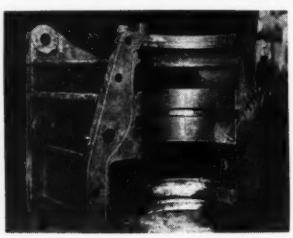

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WHAT'S NEW IN THE ELECTRICAL ART?

(Continued from page 99)

into use; one of the earliest the mercury arc, and later the copper-oxide and thermionic tube rectifiers. All these displayed better possibilities than the mechanical type and, as is well known, all of them have reached a high state of perfection.

The mechanical rectifier, therefore, was more or less relegated to the discard—until the recent war was over. Then, it was found that the Germans had developed a type of mechanical rectifier that had handled currents as high as 5000 amp at 400 v. And this is why, at this meeting of the AIEE, there was a conference devoted solely to the subject of mechanical rectifiers.

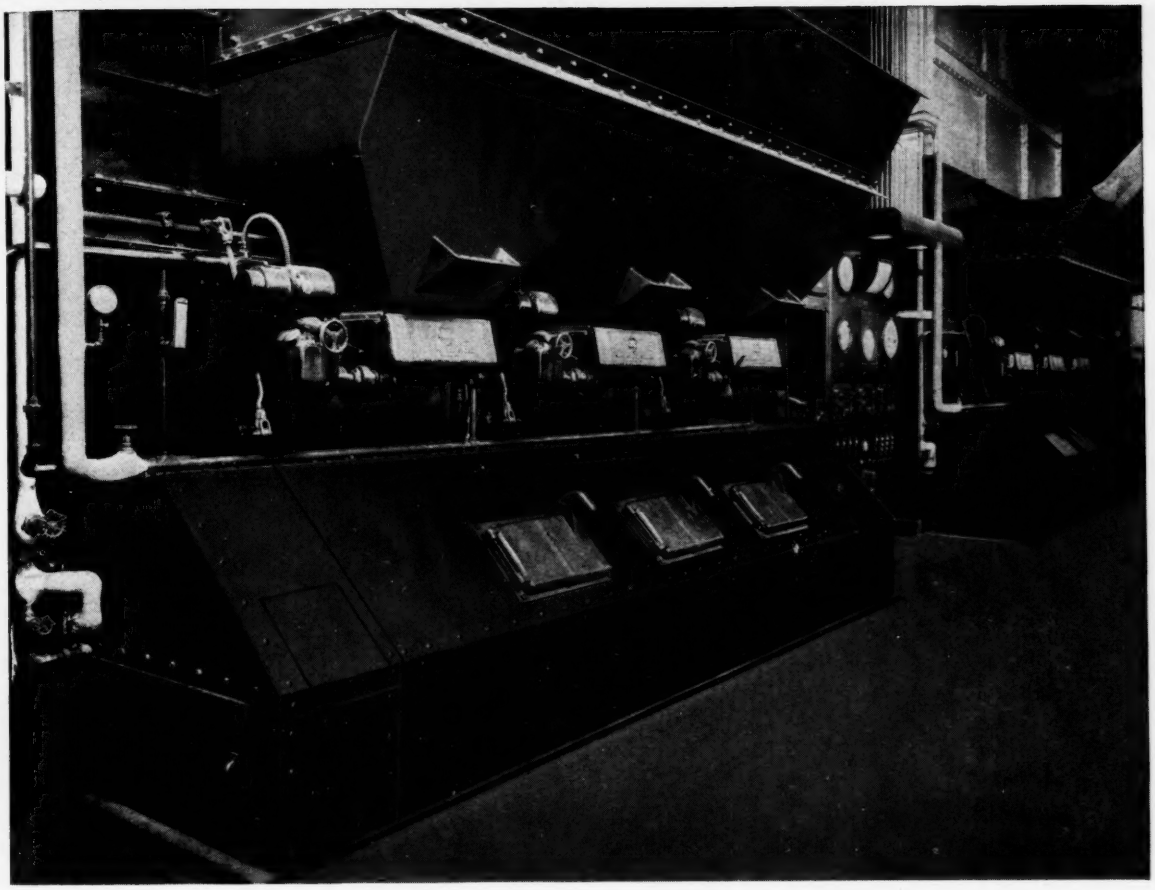
This session began in a harmless sort of way but before it was over it showed that engineers were quite human and quite capable of the same kind of prejudiced thinking that characterizes the rest of the so-called, human race. The really important paper at this conference was one presented by Otto Jensen of the I. T. E. Circuit Breaker Co., describing the German Mechanical Rectifier. Shortly after V-E day, Mr. Jensen was a member of a commission which visited Germany for the purpose of gathering data on German technical developments. Among other things, he found the mechanical rectifier and subsequently brought one over to America and set it up in the I. T. E. factory in Philadelphia. There they studied it and made a number of improvements. As a result, this unit, today, is delivering d-c to the I. T. E. power system, and obviously is doing a good job.

Mr. Jensen's delivery was excellent —informative, and at the same time amusing. More amusing, however, was the attempt by representatives of other American electrical manufacturers to belittle the German development. All of them apparently had tackled the mechanical rectifier years ago and all of them too, it seems, were well aware of what was going on in Germany, even before the war. Even the representative of Brown Boveri claimed his firm had discarded the idea of the mechanical rectifier 25 or 30 years ago, but also pointed out that they had built a very successful unit shortly before the war. All of them admitted the Germans had done a good job but that the mechanical rectifier in this country—well, it just wasn't so hot.

German Rectifier Uses Commutating Reactors

The successful operation of the German units is due to the use of commutating reactors, which alters the wave shape at the current zero so as to permit the rectifier contacts to open and close over a relatively

The PROOF is in the RE-ORDER



...TWO MORE BROS TRAVL-SPRED STOKERS INSTALLED

Bros Travl-Spred Stokers combine both spreader feed and traveling grate . . . to give uniform fuel distribution plus continuous ash discharge.

In addition, they have the *Bros*-designed *tuyere-type grates* in individual units with cooling ribs for longer life . . . *zoned burning areas* to assure correct volume of air through various depths of the ash bed . . . and *hydraulic drive* for continuous operation at minimum cost.

All this is combined into a compact installation readily adaptable to existing boiler rooms . . . capable of *increasing steam output* and *decreasing power costs.*

For proof, take the case of the Chicago, Milwaukee, St. Paul and Pacific Railroad. The CMSTP&P installed two *Bros Travl-Spred* Stokers in their Milwaukee plant in the spring of '46. Today, they are installing *two more* in the same boiler room.

And we can show you hundreds such re-orders—the world's best proof of satisfactory performance. What's more, we can show you the exact *Travl-Spred* Stoker best suited to your requirements . . . a stoker that will give you more efficiency *and* more economy in steam production. So write to: Wm. Bros Boiler and Manufacturing Co., Minneapolis 14, Minnesota.

BROS

WATER TUBE, FIRE TUBE BOILERS • OVER FEED, UNDER FEED • HYDRAULIC-TRAVL-SPRED STOKERS

Proven power and endurance for cleaning SMALL TUBES

Roto Division - Elliott Company
Newark 1, N. J.

Gentlemen:

On receipt of your miniature tube cleaning equipment, I was a bit dubious of its qualifications to carry out the job it had to do. It has cleaned 4,000 3/4"x 24' copper-nickel tubes, and has done this job well. All suspicions of its staying qualities have been removed.

I can heartily recommend this equipment. Thanking you.

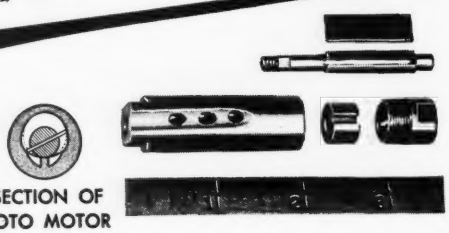
Yours respectfully,

(Signed) Chief Engineer
(Large municipal power plant)

NOTE- This is unsolicited

Model 34 Roto Junior Motor with wire flexible coupling and expanding brush for 15/16" I.D. tubes.

Model 39 Roto Junior Motor with pivot head, universal joint and air valve for 1¾" I.D. tubes.



SECTION OF ROTO MOTOR

The secret of the power and endurance of the Roto Junior Tube Cleaner is its extreme simplicity of design and precision construction. It has only two moving parts, a shaft and a blade. Positive contact between the blade and the Rotocentric bore cylinder assures an undivided air stream and freedom from leakage. Its convenient size, speed, and ease of operation, offer a marked contrast with external cleaners costing many times more. Send for bulletin.

ROTO Junior TUBE CLEANERS

ELLIOTT COMPANY-ROTO DIVISION
147 Sussex Avenue, Newark 1, N. J.

long interval of time. American manufacturers, it seems, were quite familiar with commutating reactors; indeed they are used in connection with mercury arc rectifiers.

Mr. Jensen showed the efficiency curves of the mechanical rectifier and they are considerably higher than either the rotary converter, the motor-generator or the mercury arc rectifier, and furthermore, these units involve far less material—copper and iron—than the other types.

Despite the rather poor repute in which the mechanical rectifier is held by the representatives of the other American electrical manufacturing companies as well as Brown Boveri, there is a great deal of interest in the mechanical rectifier in America, and Mr. Jensen said they had orders for some ten of these units, one for a large electrochemical plant in Buffalo. As in many other instances, Mr. Jensen said, now that the news was out, they were holding a post-mortem before the baby was even born.

Metallic Rectifiers

This session on mechanical rectifiers was held on Thursday afternoon. In the morning of that same day, there was a session on "Metallic" rectifiers. This session was something of an anniversary—roughly the 25th anniversary of the copper oxide rectifier. This conference was led by a brief review of the history of the copper-oxide rectifier, by L. O. Grondahl, the discoverer of the copper-oxide rectifier. This was followed by discussion by representatives of different branches of the electrical field, describing the applications of the copper-oxide rectifier.

Few, except those closely associated with the manufacture and application of the copper-oxide rectifier, realize how much these rectifiers enter into practically every element of our daily life. They are used widely in industry, in furnishing direct current for welding and electroplating. It has a great range in size and capacity. It has been used in applications from radio detection and instrument rectifiers to modulation and demodulation in radio and telephone systems. It has found many auxiliary uses, such as the absorption of energy in magnetic coils and the snubbing of relays, click reducers in telephones. For these purposes, these units have varied in capacity from a few microamperes in discs that are only 0.03 in. in diameter, to currents of 25,000 to 100,000 amp in plating rectifiers.

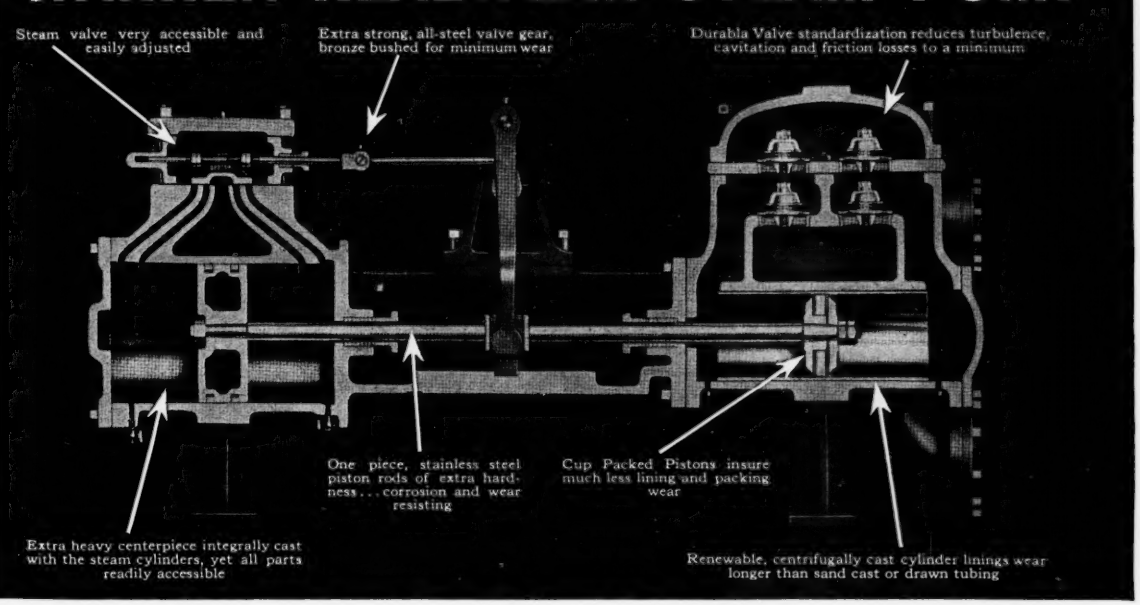
Edison Medal to Dr. Slepian

The Edison medal, this year went to Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories. The award was made for his outstanding contributions to lightning protection, high voltage circuit breakers, and rectifiers, specifically the ignitron rectifier. It was

A TYPICAL EXAMPLE OF

Superior Pump Engineering

WARREN REALWEAR STEAM PUMP


Steam valve very accessible and easily adjusted
Extra strong, all-steel valve gear, bronze bushed for minimum wear
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One piece, stainless steel piston rods of extra hardness . . . corrosion and wear resisting
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Extra heavy centerpiece integrally cast with the steam cylinders, yet all parts readily accessible
Renewable, centrifugally cast cylinder linings wear longer than sand cast or drawn tubing

THE Warren "Realwear" is an example of engineering from *your* viewpoint. Notice the plus features in the cutaway view above. Compare with any similar make.

This is the type of engineering that goes into *every* Warren pump—both reciprocating and centrifugal. Dependability, maintained efficiency with low maintenance costs are first considerations. Let us talk with you about your next pumping problem. Write:

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Atlanta Boston Chicago Cleveland Denver Detroit Houston
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Warren Pumps

CENTRIFUGAL AND RECIPROCATING

P-10

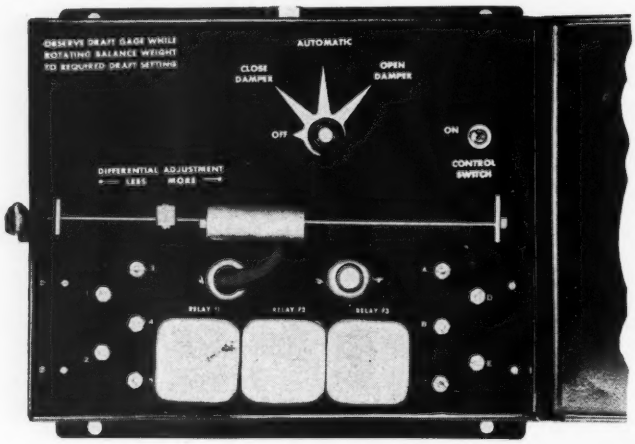
ELECTRIC DAMPER CONTROL

with automatic time-delay features

AT A PRICE YOU CAN AFFORD*

FOR STOKER, OIL, OR GAS-FIRED BOILERS

All controls in one compact cabinet which is installed in any convenient location in the boiler room.



The Cleveland Electric Damper Control now brings automatic boiler operation within the means of every plant, providing all the elements for safe, automatic control of stack draft.

Saves Fuel—Reduces Smoke

This unit usually *pays for itself* in fuel savings in less than a year. It brings the added benefits of *protection to boiler plant equipment, reduction of smoke, soot and fly ash,* and *increased safey of boiler operation.*

Technical Features

Differential Adjustment permits easy adjustment to any desired sensitivity. *Selector Switch* gives complete manual control when desired —permitting full stack draft for soot blowing, inspection, etc., also full closed draft for boiler repairs, reduced load, etc. *Emergency Cut-Out Switch* makes it possible instantly to cut out all automatic draft control. Interchangeable *Application Plug* adapts the control to stoker, oil, or gas firing—permitting same unit to be used with any fuel.

Safe Step-by-Step Operation

Three Plug-in Relays provide necessary time delay. For Stoker-fired boilers: Relay No. 1 opens damper when system calls for firing, Relay No. 2 starts stoker when damper is open and Relay No. 3 then places damper on automatic modulated control until start of a new cycle. For Oil-and Gas-fired boilers: Relay No. 1 opens damper, Relay No. 2 starts ignition system when damper is open, and Relay No. 3 starts automatically controlled draft, closing damper when burner goes off.

**Typical Installations in Laundries, Greenhouses, Dairies, Hotels, etc. have been made with the average total cost approximately $350—including CFE Draft and Air Pressure Gauges, Pyrometer, Electric Drive unit and installation. Write for bulletin.*

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CLEVELAND FUEL EQUIPMENT CO.

Complete Line of Combustion Instruments and Controls

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Dr. Slepian who first enunciated the theory of deionization in arc interruption and this led to his development of the deion circuit breaker. This, for the first time, placed circuit breaker theory on a sound theoretical basis and it led to the development of breakers such as those which, last summer, interrupted circuits of 7,500,000 kva capacity. Few men, single handed, have contributed as much to the solution of difficult practical electric power problems as has Dr. Slepian.

The award was made to Dr. Slepian at the General Session on Wednesday morning by Blake D. Hull, President of the Institute. In his address of acceptance, Dr. Slepian spoke briefly on the relative function of the mathematician, the physicist and the engineer in the scheme of modern technology.

A most interesting feature of this General Session was the lecture, following Dr. Slepian's address, by Jack T. Wilson, physicist of Allis-Chalmers Mfg. Co.

Dr. Wilson spoke on Solar Radiation and its effect on power transmission and radio communication. In the course of this lecture he showed a remarkable movie film, taken with the Coronagraph, a new device by means of which it becomes possible to photograph the solar corona at any time. Heretofore, this could only be done at a time of a total eclipse.

Synthetic Crystals

Fascinating was the meeting on Friday morning devoted to the subject of Synthetic Crystals. Artificial crystals grown in the laboratory from ordinary chemicals are beginning to be used in the nation's expanding telephone network as a substitute for scarce but heretofore indispensable natural quartz. The new crystals, ethylene diamine tartrate, are familiarly known as EDT. Although these crystals differ markedly from quartz in chemical composition, both are piezo-electric in character; that is, they can convert mechanical energy into electrical energy and vice versa. Thus they are useful as electrical filters and are used in long-distance telephone lines for keeping separate the many different telephone conversations in a carrier system.

The new crystal is the direct result of long-range research on growing artificial crystals, which has been in progress for a quarter of a century. And now, at the very time when the great expansion in telephone service threatened to outrun the available supply of quartz, this development has come to a successful end. Thus the Bell system has almost completely relieved itself of the necessity of importing quartz and has guaranteed the continued expansion of our telephone system.

Of great interest was the beautiful colored motion picture showing the

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ROSS "BCF" COOLERS

For oil or water in small to medium size engines, turbines, gears or hydraulic presses

● A growing number of major equipment builders, in looking out for your interests, are installing Ross "BCF" oil and water coolers as *original equipment.*

On the other hand, many equipment builders leave it to their dealers to furnish Ross "BCF" Coolers as an optional accessory.

Either way, the chances are that the oil or water cooling will be done by a "BCF" unit when your next hydraulic press, plastic injection molding machine, die-casting machine, Diesel or gas engine, compressor, hydraulic coupling, torque converter, reduction gear, thrust bearing or turbine is placed into operation.

By this selection, both builders and dealers are providing you with: maximum heat transfer efficiency packaged in a compact, relatively small unit; extra rugged construction to withstand higher pressures; a favorable initial cost through standardization of a carefully engineered design; all nonferrous materials to prevent rust and corrosion; roller expanded, permanent, leak-proof tube joints; easy accessibility for inspection and cleaning.

It will be well worth your inquiring about the type oil or water cooler planned for your equipment. If it's not a Ross "BCF", familiarize yourself and then *insist* upon it! *Bulletin 4922, with complete design details, will be furnished gladly upon request.*

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Division of American Radiator & Standard Sanitary Corporation

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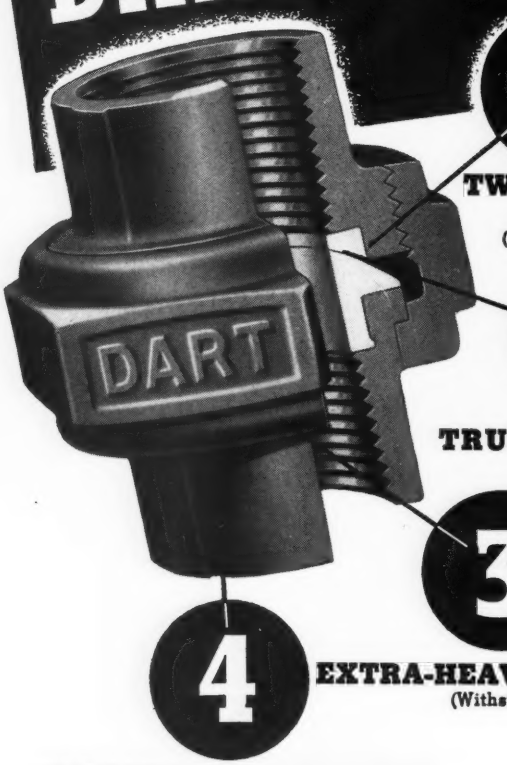
Ross equipment is manufactured and sold in Canada by Horton Steel Works, Ltd., Fort Erie, Ontario

4 Good Reasons for Specifying DART UNIONS



1 **TWO BRONZE SEATS**
(Non-corroding)

2 **TRUE BALL JOINT**
(Leak-proof)

3 **EXTRA-HEAVY SHOULDERS**
(Withstand abuse)

4 **MALLEABLE IRON BODY**
(Practically indestructible)

These Dart advantages all spell ***longer life.*** Because of the two precision-ground bronze seats, Darts are non-corroding on ***both*** sides of the true ball joint, making a drop-tight leak-proof connection. They open and close ***easily*** without excessive wrenching, and can be reused over and over. Body and nut are made of high-test, air-refined malleable iron—practically indestructible.*

Ask your supplier to demonstrate these advantages.

DART UNIONS

E. M. DART MFG. CO.
Providence 5, Rhode Island

process of growing these crystals. This movie was as artistic as the process it showed was technical. This development shows the endless ramifications of the electrical industry.

Basic Sciences

In this all but endless array of development, of new techniques, processes and devices, the basic sciences were not neglected. There was a conference on Applied Mathematics devoted to the subject "What the Engineer Can Do with His Experimental Data." Basic properties of materials, attenuating materials for microwaves, insulation breakdown as a function of area, were considered in various papers on these subjects.

In conclusion, it is gratifying to point out that this meeting was well organized and well handled. The facilities of the Hotel William Penn, where all the meetings were held, were adequate and, on the whole, exceptionably comfortable. All the public address systems "worked," the stereopticon equipment and the motion picture projectors all were adequate and the operation excellent. The meeting rooms were well ventilated, the lighting excellent and the chairs comfortable and their number ample. Main entertainment features were the "Smoker" on Tuesday night and the Dinner Dance on Wednesday.—A. W. K.

NEWS *from* THE FIELD

MIDWEST POWER CONFERENCE PROGRAM

FOLLOWING is a preliminary schedule of panels and papers of the Midwest Power Conference to be held April 7, 8, 9 at the Sheraton Hotel (formerly the Continental Hotel) Chicago.

Three luncheons and one dinner are on the program: Luncheon, 12:15 p.m., Wednesday, April 7, $3.25; Luncheon, 12:15 p.m., Thursday, April 8, $3.25; All Engineers Dinner, 6:45 p.m., Thursday, April 8, $4.50; Luncheon, 12:15 p.m., Friday, April 9, $3.25. Conference Secretary is Edwin R. Whitehead, Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.

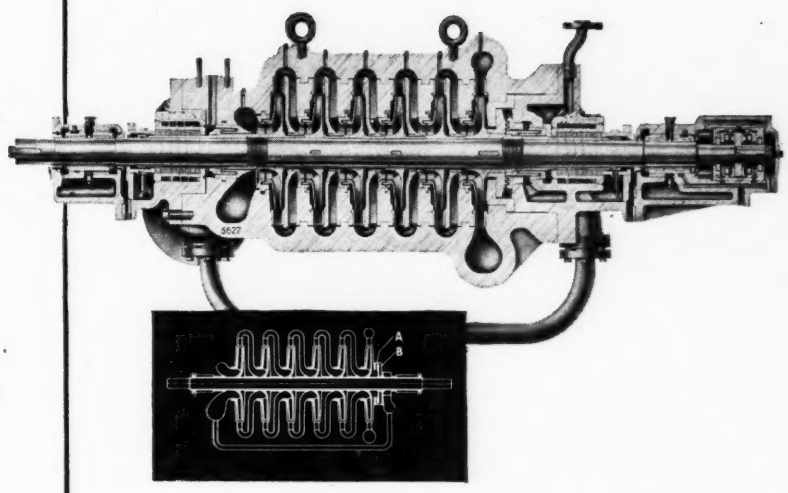
Wednesday, April 7, 1948

8:30 A.M. Registration, Sheraton Hotel.

10:00 A.M. Opening Meeting. Chairman: Henry T. Heald, President, Illinois Institute of Technology.

(a) Address of Welcome. D. D. Ewing, Head, School of Electrical Engineering, Purdue University.
(b) Estimates of Future Electric-Power Needs of the United States. F. R. Benedict, Manager, Industry Engineering Dept., Westinghouse Electric Corporation, East Pittsburgh.
(c) Flood Control and Power in the Southwest. Edwin Vennard, Vice President, Middle West Service Co., Chicago.
(d) The Trek of Industry Westward. John

ALL THRUST ALWAYS BALANCED



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How the thrust is balanced

Any unbalanced thrust causes the rotor to shift axially, thus regulating flow through clearance A, thereby controlling pressure against balancing disc B and thus automatically returning the pump to a state of perfect balance.

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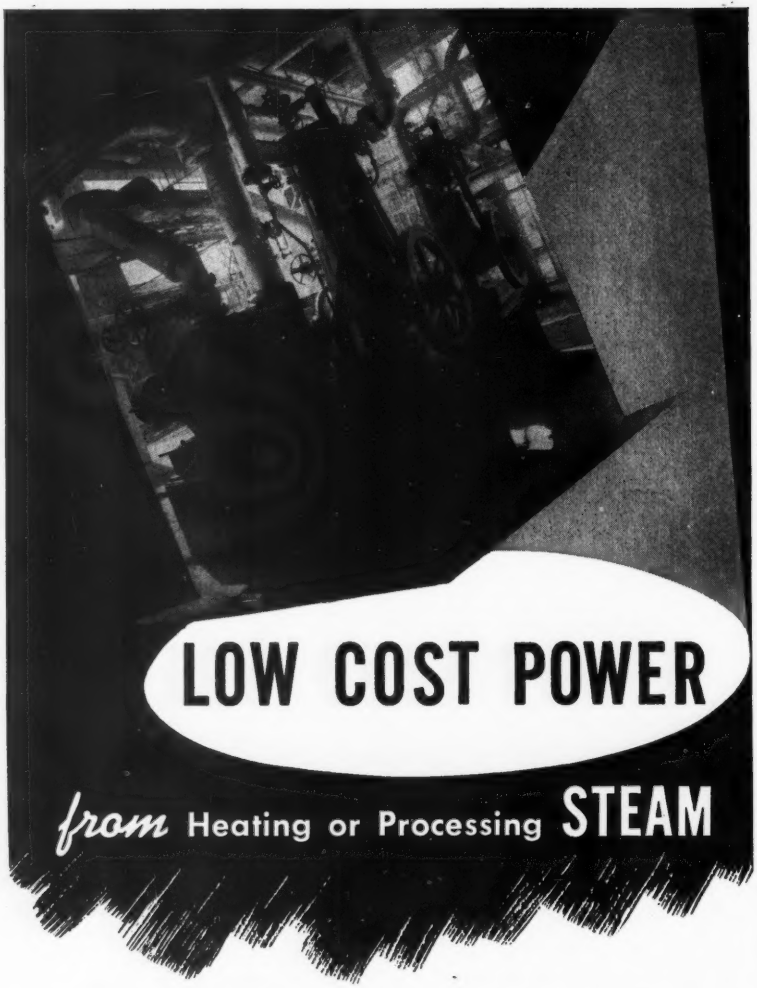

If you are generating steam for processing or heating, a modern Troy-Engberg Steam Engine may be the unit to provide the lowest cost power for your plant. The story is really elementary — so elementary it might be overlooked.

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TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

M. Drabelle, Chief Mechanical and Electrical Engineer, Iowa Electric Light and Power Co., Cedar Rapids, Iowa.

12:15 P.M. Joint Luncheon with A.S.M.E. Chairman: Robert Krause, Chairman, Chicago Sect., A.S.M.E.
Speaker: Arrangements pending.

2:00 P.M. Central Station Practice.* Chairman: R. B. Gutekunst, Chairman, Power & Fuels Div., Chicago Sect., A.S.M.E.
(Sponsored and arranged by the Power and Fuels Div., Chicago Section, A.S.M.E.)
(a) Arrangements pending.
(b) Arrangements pending.

2:00 P.M. Developments in Heating. Chairman: William Goodman, Illinois Institute of Technology.
(a) Panel Heating, Design Procedures. F. W. Hutchinson, Dept. of Mechanical Engineering, University of California.
(b) Comparative Performance of Panel and Convection Systems in Research Residence. S. Konzo and R. W. Roose, Dept. of Mechanical Engineering, University of Illinois.

3:30 P.M. Diesel Power. Chairman: John W. Andeen, University of Minnesota.
(a) Combustion in Diesel Engines. Otto Uyehara and P. S. Myers, Dept. of Mechanical Engineering, University of Wisconsin.
(b) A Test Cell for Measuring Engine Noise. W. P. Green, Dept. of Mechanical Engineering, Illinois Institute of Technology.

3:30 P.M. Electrical Measurements. Chairman: F. D. Weeks, Chairman, Industrial Group, Chicago Sect., A.I.E.E.
(Sponsored and arranged by the Industrial Group, Chicago Sect., A.I.E.E.)
(a) Electrical Measurement of Nonelectrical Quantities. Everett S. Lee, Engineer, General Engineering and Consulting Lab., General Electric Co., Schenectady, N. Y.
(b) Measurement of Power and Power Factor in Industrial Plants. Erwin Boland, General Electric Co., West Lynn, Mass.
(c) D. C. High Power Distribution Systems, Short Circuit Analysis. William Deans, Chief Engineer, I.T.E. Circuit Breaker Co., Philadelphia.

3:30 P.M. Power Plant Equipment and Appraisal. Chairman: Norman A. Parker, University of Illinois.
(a) Selection of Mechanical Draft Fans. A. P. Darlington, Head, Mechanical Draft Div., American Blower Corp., Detroit.
(b) Steam Power Plant Appraisal. Harry F. Lowe, Sloan, Cook & Lowe, Consulting Engineers, Chicago.
(c) Condensers, their Use and Application in Water-Shortage Areas. R. J. Martin, Dept. of Mechanical Engineering, University of Illinois.

Thursday, April 8, 1948

9:00 A.M. Feedwater Treatment No. 1. Chairman: Ben G. Elliott, University of Wisconsin.
(a) Causes and Prevention of Condensate-Return-Line Corrosion. R. T. Hanlon, Special Service Engineer, National Aluminate Corp., Chicago.
(b) The Practical Approach to Modern Boiler Water Treatment. R. C. Ulmer, Technical Director, E. F. Drew & Co., New York.

9:00 A.M. Excitation Systems. Chairman: R. W. Watson, Westinghouse Electric Corp.
(a) Excitation Requirements and Control of Reactive Power. W. A. Lewis, Illinois Institute of Technology.
(b) Rotating Regulator Excitors. C. Lynn, Westinghouse Electric Corp., East Pittsburgh.

10:30 A.M. Hydro Power. Chairman: W. A. Lewis, Illinois Institute of Technology.
(a) Japanese Electric Power System. E. J. Burger, Vice President and Division Manager, Ohio Public Service Co., Lorain, Ohio.
(b) Sediment Transportation in Streams in Relation to Power Plant Operation. M. C. Boyer, Research Engineer, Iowa Institute of Hydraulic Research, State University of Iowa.

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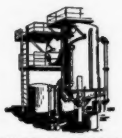
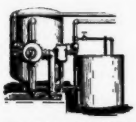


HOT PROCESS SOFTENERS



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Whether your problem includes the conditioning of boiler feed, process or cooling water, or industrial waste disposal, you will find this same experience a valuable asset in its solution. It is an experience that includes over thirty-six years of active participation in every phase of water conditioning . . . laboratory analysis and research, design of equipment, fabrication of all major parts of an installation (including tanks) and the installation and servicing of all types of equipment.

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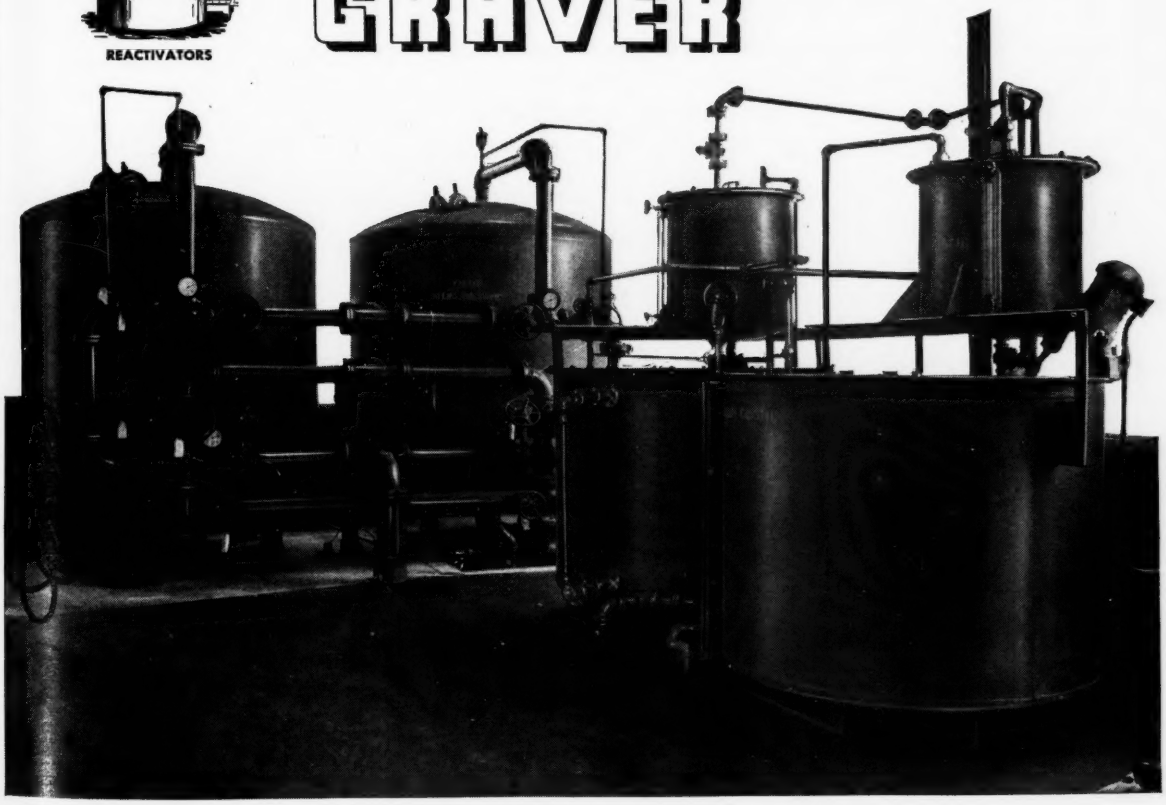
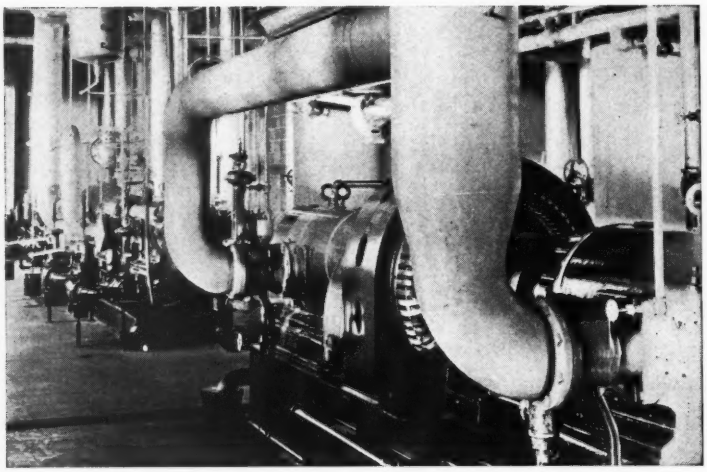


MERCK & CO., INC. installs Fuller Rotary Compressors at Elkton



Two of several Fuller Rotary Duplex Single-stage Compressors installed in the Elkton, Va., plant. Of the Units shown above, the one on the right is motor driven and the other is turbine driven. Capacity of each unit installed is 3010 c. f. m., 30-lb. pressure.

Merck: maker of Streptomycin — the modern, efficient drug. Fuller: maker of Fuller Rotary — the modern, efficient compressor. Each has its place — Streptomycin for the saving of life; Fuller Rotary for cost-saving air production.

Fuller Company is quite proud to be associated with this great project, to have had the opportunity to furnish Fuller Rotary Compressors for such a fine, efficient plant, to be able to play even a small part in this worth-while undertaking . . . the fight for life.

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C-157

FULLER
A LIFETIME OF NEW MACHINE EFFICIENCY

10:30 A.M. Locomotive Power Units. Chairman: D. D. Ewing, Purdue University.

(a) The Gas-Turbine Locomotive. P. R. Broadley, Mechanical Engineer, Central Railroad Co. of N. J., on loan as Ass't to Director of Research, Locomotive Development Committee, Baltimore.
(b) Arrangements pending.

12:15 P.M. Joint Luncheon with A.I.E.E. Chairman: Jesse E. Hobson, Chairman, Chicago Sect., A.I.E.E.

Speaker: A. C. Monteith, Manager, Headquarters Engineering, Westinghouse Electric Corp., East Pittsburgh. "Opportunities in the Power Field."

2:00 P.M. Rural Electrification. Chairman: T. O. Millard, Chairman, Power Group, Chicago Sect., A.I.E.E.

(Sponsored and arranged by the Power Group, Chicago Sect., A.I.E.E.)
(a) Rural Electrification from the Power Company Viewpoint, Grover C. Neff, President, Wisconsin Power & Light Co., Madison.
(b) European vs. American Distribution in Towns & Rural Areas. K. R. Brown, Brown Engineering Co., Des Moines, Iowa.
(c) Application of Oil Reclosers on Distribution Systems. R. O. Askey, Public Service Co. of Northern Illinois and C. V. Miller, Joslyn Mfg. and Supply Co., Chicago.

2:00 P.M. Power Plant Operator Training. Chairman: Joseph P. Flynn, President, National Association of Power Engineers.

(Sponsored and arranged by the N.A.P.E.)
Speakers:
Kenneth R. Hodges, Editor, National Engineer, Chicago.
Julius Barbour, East Lansing, Mich.
Garrett Burgess, Detroit, Mich.
Stephen C. Casteel, East St. Louis, Ill.

3:30 P.M. General Power Systems. Chairman: E. B. Kurtz, State University of Iowa.

(a) The Foreign Power Situation. Walker L. Cisler, Chief Engineer of Power Plants, Detroit Edison Co.
(b) Power System Stability. E. W. Kimbark, Dept. of Electrical Engineering, Northwestern University.

3:30 P.M. Industrial Power Plants. Chairman: M. P. Cleghorn, Iowa State College.

(a) Furnace Design Methods, With or Without Water Walls. Ollison Craig, Riley Stoker Corp., Worcester, Mass.
(b) Application of Heat Balance Analysis to Industrial Plants. H. C. Carroll, Commercial Testing and Engineering Co., Chicago.
(c) Experiences with a Multiple Fuel-Fired Water-Tube Boiler. R. Frank Hollis, General Superintendent, Alton Box Board Co., Alton, Ill.

6:45 P.M. "All Engineers" Dinner. Informal. Grand Ball Room. (Ladies Invited).

Friday, April 9, 1948

9:00 A.M. The Heat Pump. Chairman: R. A. Budenholzer, Illinois Institute of Technology.

(a) Heat Source Possibilities of the Earth (Milwaukee Area Heat-Pump Study). Charles H. Randolph and O. O. Wagley, Wisconsin Electric Power Co., Milwaukee.
(b) Investigation of the Heat Pump for the Chicago Area. M. S. Oldacre, Director of Research, Utilities Research Commission, Chicago.

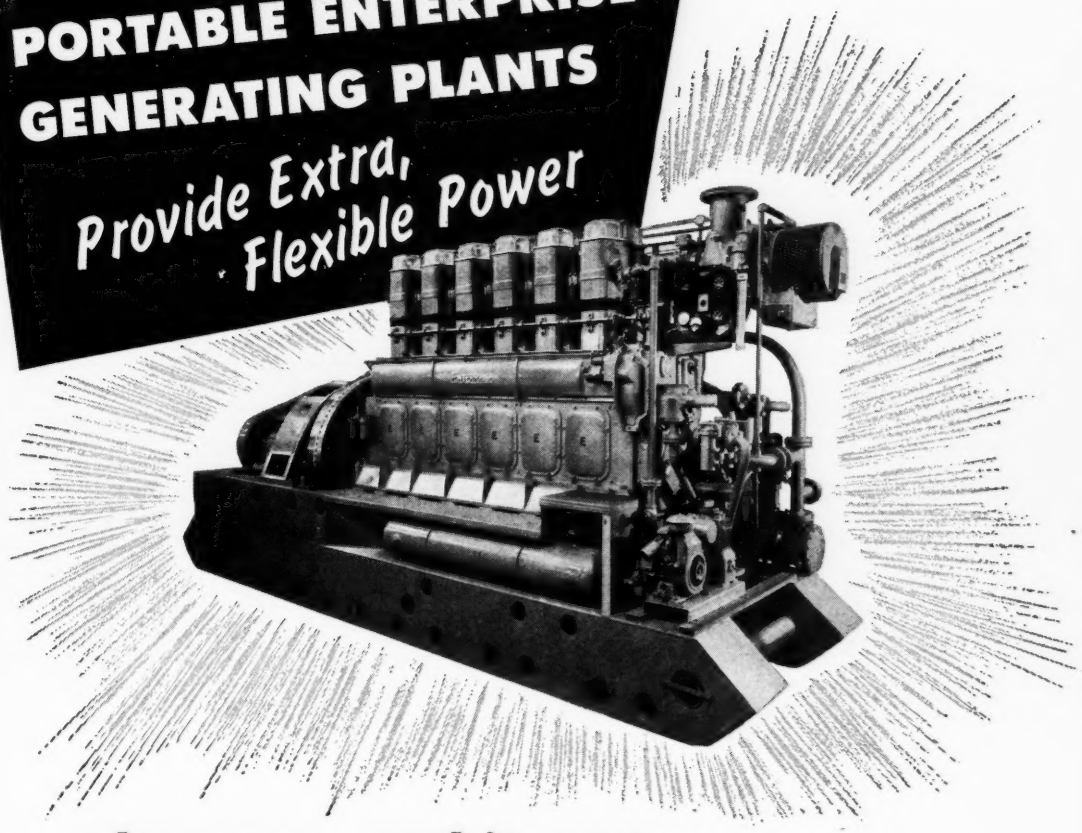
9:00 A.M. Feedwater Treatment No. 2. L. G. Miller, Michigan State College.

(a) Use of High Alkalinity and Organic Materials for Sludge Removal in H-P Boilers. Selden K. Adkins, Chemist, Omaha Public Power Dist., Omaha, Neb.
(b) Recent Developments in Boiler Water Research. F. G. Straub, Research Professor in Chemical Engineering, University of Illinois.

10:30 A.M. Power and Control. Chairman: A. H. Wing, Chairman,

PORTABLE ENTERPRISE GENERATING PLANTS

Provide Extra, Flexible Power



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Versatile and rugged, this portable addition to the Central Electric and Gas Company's South Dakota operations is destined for years of reliable service to the people of the state—*whenever* and *wherever* it is needed most. This compact generator set is currently serving to augment existing plant facilities at Phillip, S.D., during the overload period of the winter months. It will thereafter be available for emergency service in other South Dakota communities.

This Enterprise DSG-36 unit is rated 694 HP at 450 RPM, developing 480 KW. It is designed to parallel with other units wherever it may be needed. Accessories for starting and cooling are mounted upon the one skid base to simplify and to reduce the time necessary for setting up.

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So, if you need accurate information on "how fast it is running" — instantly and accurately — plan for the installation of Henszey Flow Indicators. Installations satisfactorily performing in Paper Mills, Chemical Plants, Petroleum Refineries, Milk Condenseries, and other varied industries.

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Electronics Group, Chicago Sect., A.I.E.E.
(Sponsored and arranged by the Electronics Group, Chicago Sect., A.I.E.E.)
(a) Circuit Principles of Industrial Electronic Control. Walther Richter, Allis-Chalmers Manufacturing Co., Milwaukee.
(b) Rectifier Power Supplies from D-C Systems. C. R. Marcum, Westinghouse Electric Corp., East Pittsburgh.
(c) Electronically Controlled Variable-Speed Drives.

10:30 A.M. Fuels and Combustion. Chairman: R. Clay Porter, University of Michigan.
(a) Experiment on Underground Gasification in the United States. W. C. Schroeder, Chief, Office of Synthetic Liquid Fuels, Bureau of Mines, Washington, D. C.
(b) Possibilities of Coal Processing in Power Production. A. D. Singh, President, Singh Co., Chicago.

12:15 P.M. Joint Luncheon with W.S.E. Chairman: William V. Kahler, President, Western Society of Engineers.
Speaker: Charles E. Friley, President, Iowa State College.

2:00 P.M. General Session. Chairman: Herman Halperin, Chairman, Civic Committee, Western Society of Engineers.
(Sponsored and arranged by the W.S.E.)
Subject: The Engineer in Civic Affairs.
Speakers: S. M. Dean, Chief Engineer of the System, Detroit Edison Co.
Henry T. Heald, President, Illinois Institute of Technology.

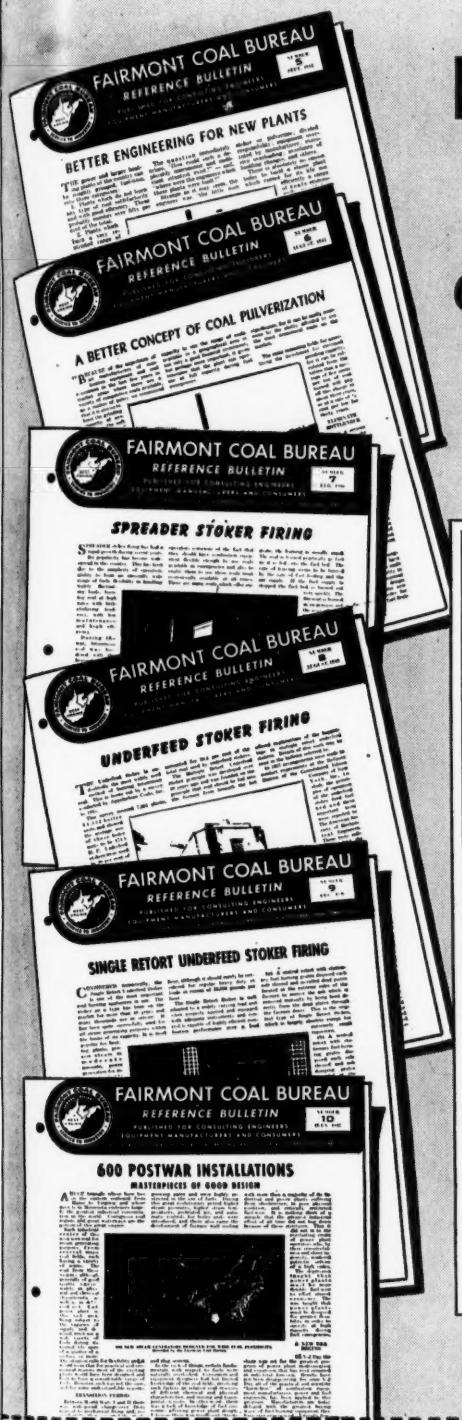
2:00 P.M. Supervisory Control and Telemetering. Chairman: E. H. Schulz, Armour Research Foundation of Illinois Institute of Technology.
(a) Telemetering of Power, Reactive Power, and Similar Quantities. Nathan Cohn Leeds and Northrup Co., Chicago.
(b) Telemetering Channels. R. J. Donaldson, Commonwealth Edison Co., Chicago.
(c) Supervisory Control. A. P. Peterson, President, Control Corporation, Minneapolis.

3:30 P.M. The Gas Turbine. Chairman: John T. Retaliata, Illinois Institute of Technology.
(a) Progress Report on the Coal-Burning Gas Turbine. J. I. Yellott, Director of Research, and C. F. Kottcamp, Asst. to the Director, Locomotive Development Committee, Baltimore.
(b) Why So Many Gas Turbine Cycles. L. N. Rowley, Managing Editor, and B. G. A. Skrotzki, Associate Editor, *Power*, New York.
(c) Operation and Test Experience with an Experimental 2000-hp Gas Turbine. T. J. Putz, Westinghouse Electric Corp., Philadelphia.

3:30 P.M. Conductors. Chairman: K. W. Miller, Armour Research Foundation of Illinois Institute of Technology.
(a) Development of Requirements for Copper Wire Connections. Frank E. Sanford, Director of Research, Copper Wire Engineering Association, Chicago.
(b) Synthetic Rubbers and Resins as Insulation for Wires and Cables. J. T. Blake, Director of Research, Simplex Wire and Cable Co., Cambridge, Mass.

ASLE CONVENTION

The American Society of Lubrication Engineers will hold its third annual convention on April 19, 20 and 21, at the Hotel Statler, Buffalo, New York. Running concurrently with the convention will be the first all-lubrication show ever to be held. Members and guests will have an opportunity to view the products of leading manufacturers of lubricants, lubricating systems and lubricating devices, according to W. F. Leonard, Sec.-Treasurer of the Society. An extensive program of subjects pertaining to many phases of lubrication have been prepared. A registration of 1000 members and guests is expected at the Technical Sessions.



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The Fairmont Coal Bureau serves industry through fuel studies and the dissemination of literature valuable to every one interested in fuel burning. Whatever your steam generator requirements . . . FIVE THOUSAND POUNDS, OR A MILLION . . . there is a place in your library for the Fairmont Coal Reference Bulletins. Operating personnel and executives alike will find these concisely written Bulletins the practical answer to today's higher operating costs. These technical bulletins will be of interest and assistance to every one planning the installation of new steam generating equipment, or the modernization of old.

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- 2½ to 1 guide ratio of the disc guide assures full lift and positive reseating.
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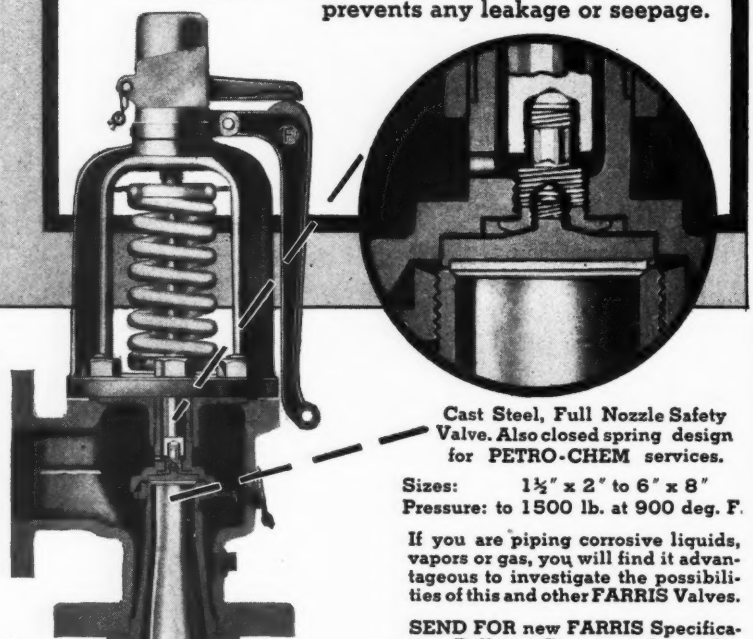

Cast Steel, Full Nozzle Safety Valve. Also closed spring design for PETRO-CHEM services.

Sizes: 1½" x 2" to 6" x 8"
Pressure: to 1500 lb. at 900 deg. F.

If you are piping corrosive liquids, vapors or gas, you will find it advantageous to investigate the possibilities of this and other FARRIS Valves.

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SAFETY and RELIEF VALVES

FARRIS keeps pace with advancing power and process engineering

New ENGINEERING BOOKS

Industrial Experimentation, by K. A. Brownlee; first edition, 5½ by 8¾ in., 152 pages, cloth; published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1947; price $3.75.

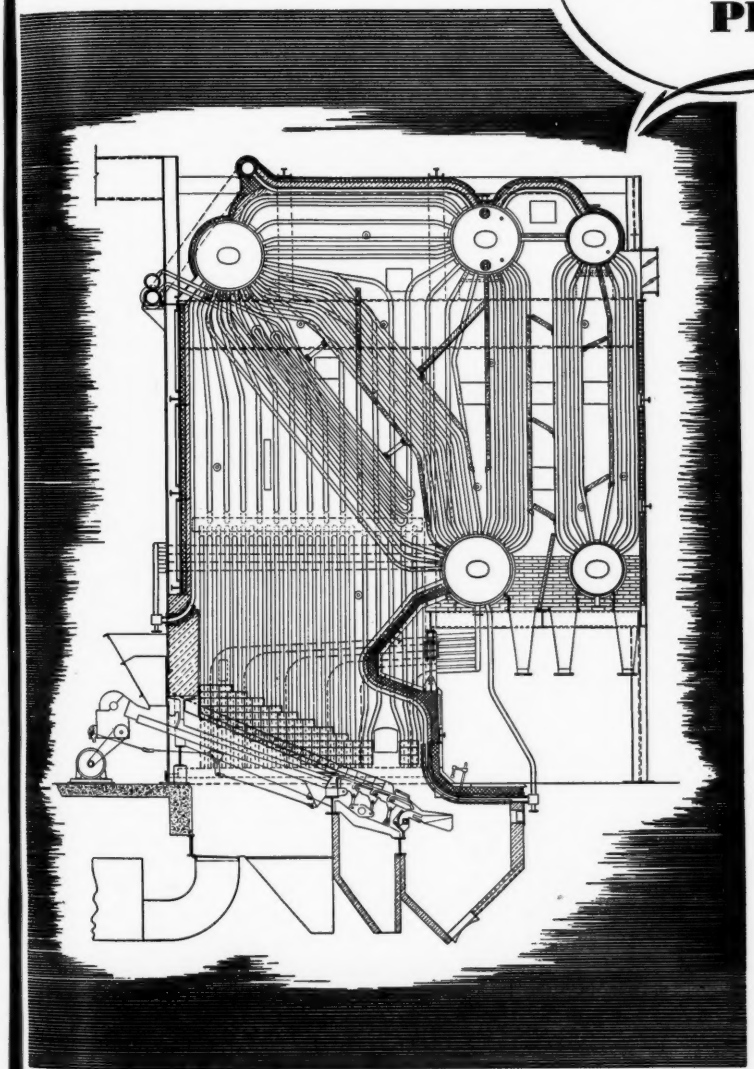
This book is designed primarily for the use of those concerned with pilot-plant and plant-scale experiments on chemical manufacturing processes. The statistical methods presented have long proved to be of great value in other fields of experimentation, notably agriculture. Those who must apply critical tests of statistical significance in practice, often without a full knowledge of their theoretical background, will find this volume particularly useful. It is a guide to both the planning and interpretation of experiments on an industrial scale and paves the way to efficient quality control. The subject is treated entirely from the practical point of view. Theory is at a minimum and the only mathematics involved is simple arithmetic. Each statistical method discussed is illustrated with practical examples worked out in detail to show what exactly is involved in its use. Some of the more advanced techniques may appear rather formidable but it is strongly recommended that they should be approached through the use of the simpler methods.

How to Design and Install Plumbing, by A. J. Matthias, Jr., 5½ by 8½ in.; published by the American Technical Society, Chicago, Ill., 1947, 435 pages; price $3.50.

The author of this book is a licensed master plumber in Milwaukee, Wis., and as such knows what he is writing about. While he spends a good deal of space on domestic and commercial plumbing, he also devotes much practical discussion to plumbing in industry. He takes up the cross-connections that can be harmful to health in industrial plants where two sources of water are used. Flashing on the roof for the vents, hanging pipe of various kinds, multiple connections to a common line, traps used on urinals, basins and sinks, are shown and the best use for each discussed. The author expends much space to siphonage from contaminated sources to the drinking water with many sketches to illustrate clearly what he means. Soil, waste, and vent pipe installations are shown for application in different cases. Testing of the water supply system, the vent, waste, and storm systems, are treated practically. He presents in practical terms the way to figure all the problems that come up in connection with laying out a plumbing system and figuring the amount of pipe and fittings that will be necessary to do the job according to health standards.

The use of purifiers, both mechanical and chemical, is gone into deeply enough for general knowledge and use without becoming too involved. Fire line installations are discussed with the average fire code in mind. Quite a bit of space is spent in showing and discussing all the various types of plumbing fixtures without getting into the special fixtures. As he goes from one to the other he tells how each should be connected to hot and cold water supply, vented, and the waste carried away. For practical use in figuring the amount of space needed for different fixtures he presents dimensional sheets. He discusses industrial waste and disposal of it through treating plants of small size, following it through the various stages and showing what happens to it as it progresses. The book is well illustrated with well chosen photographs and drawings and with many tables to help the plumber or handy man in figuring all lengths and sizes of pipe and fittings. In the back Mr. Matthias gives a list of questions pertaining to plumbing in general and to chapters in the book.

70,000
POUNDS OF STEAM PER HOUR



Purchaser—

Bergstrom Paper Co.

Location—

Neenah, Wisconsin

Number of Boilers.....1
(3 Similar Erie City Steam Units Installed in 1929)

Pounds of Steam/Hr. .70,000

Design Pressure.....325 PSI

Operating Pressure . 300 PSI

Final Steam Temperature.....575° F.

Economizer..... Erie City 2 Drum Integral

Water Walls..... Erie City

Sides—Cast Iron Armored at Stoker Line

Front—Bare Tube

Bridge Wall—Armored and Bare Tube with Mixing Arch

STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizers • Underfeed Stokers • Welded Pressure Vessels for the Process Industries.

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SINCE 1840

ERIE CITY IRON WORKS • ERIE, PA.

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—no pulse, but very much alive!

SIER-BATH GEAREX PUMPS are sturdy positive displacement units that discharge liquid without pulse or vibration. This is accomplished by means of double helical pumping rotors and discharge passages of proper area to insure continuous overlapping displacement of liquid. The rotors are not in contact, thus reducing wear and increasing life. If you are interested in pumping efficiency with low maintenance costs, write us for booklet.

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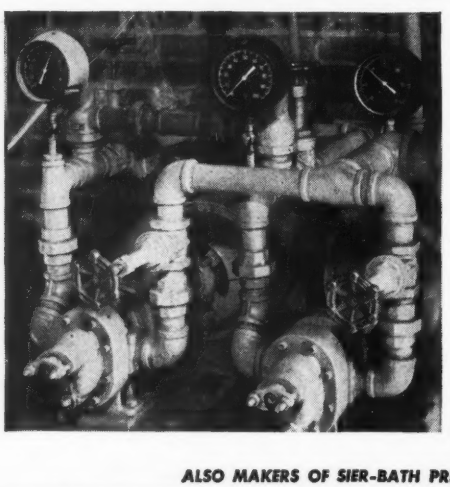
Balanced axial thrust • Vibrationless operation • Roller bushings for precision running under load.
Pumps: Oils, varnishes, solvents, molasses, chemical solutions
Capacities: 1-550 g.p.m.
Discharge: 250 p.s.i. for medium or high viscosities. 50 p.s.i. for water.



• The two Sier-Bath Gearex Pumps shown are installed in the boiler house of Metakloth Company, Lodi, New Jersey. They pump Bunker C fuel oil to the boiler at a pressure of 60 lbs. The user expresses complete satisfaction with the installation, which was made in December 1946.

★

For higher pressures and capacities
use
SIER-BATH SCREW PUMPS

ALSO MAKERS OF SIER-BATH PRECISION GEARS

FOUNDED 1905 **MEMBER A. G. M. A.**

Sier-Bath
GEAR and PUMP CO., Inc.

9256 HUDSON BOULEVARD • NORTH BERGEN, NEW JERSEY

HELPFUL BULLETINS

Continued from page 38)

as technical information, operating hints and size tables. Bulletin closes with complete listing of company tube cleaner sizes. Thomas C. Wilson, Inc.

42 **Battery Charging**—Automatic-battery-charging equipment for electric industrial trucks are described in this 12-page bulletin. The single and multiple-circuit charging units are illustrated and discussed in the text. Method of operation is described. Construction features are detailed. Useful technical information is given on how to select the proper equipment. Two tables give amp-hr capacities of batteries; charging characteristics of storage batteries are graphed; standard specifications for automatic battery-charging equipment are noted. Included are typical installation photographs. General Electric Co.

43 **Leak Sealer**—This 4-page leaflet describes the advantages of an iron cement, used to seal leaks in concrete, brick or stone walls and floors. It explains how the cement may be applied to inside as well as outside surfaces, and used on either wet or dry surfaces. It also illustrates other uses for this composition, including surfacing and dust-proofing new concrete floors, and lining cisterns, tanks, etc., repointing joints between brick, concrete or stone blocks, and sealing openings around piping extending through walls or floors. Smooth-On Mfg. Co.

44 **Resurfacing**—Featured in this 2-page bulletin is a resurfacer that can be used for the heaviest industrial service, and which comes in six colors. Method of applying the product is illustrated, and discussed in the text. Detail drawings show how the resurfacer may be applied to either wood or concrete. Flexrock Co.

MISCELLANEOUS

45 **Sealed Air Chambers**—Water hammer—its cause and cure—is the subject of this 6-page Bulletin 12P. Included are facts about the sources of water hammer, its damage and the way it can be prevented. Selector tables are included to show the correct size sealed air chamber to use in preventing water hammer damage. Wade Mfg. Co.

46 **Traveling Grate Stoker**—This 4-page bulletin is devoted to a traveling grate stoker for anthracite with boiler size range from 25 to 250 hp. The various sections of the stoker are illustrated. Two drawings show the front elevation, left, and the side elevation, right, of the stoker. Included is a discussion of the possible maintenance of the unit and the fully automatic operation. Coke Stoker Engineering Co.

47 **Roller Bearings**—This Catalog No. 2196, 14 pages, contains tables of dimensions, weights, bearing capacities at given rpm, shaft fit tolerances, housing fit tolerances, and the necessary data for calculating the required bearing capacity for different types of machinery. Method is shown how to select the proper bearing. Link-Belt Co.

48 **Variable Gear**—Folder No. 1874-A is devoted to a description of these gears with 25 hp—ratios 2:1, 3:1 and 4:1 and 20 hp—ratios 5:1 and 6:1. Photographs show typical installations, and the inside mechanism of the gear. List price is stated. Included are dimensional drawings and variable speed tables. Link-Belt Co.

49 **Magnetic Separation**—Catalog No. 11, 8 pages, first contains a discussion of the function and services of the company magnetic laboratory. The purpose, construction and operation of a magnetic tube tester is then explained, followed by a description of the application, operation and specifications of the wet type separator, induced roll, type IR separator and a cross belt type separator. All separators are illustrated with photographs. The operating principle of the induced roll separator is diagrammed. Dings Magnetic Separator Co.

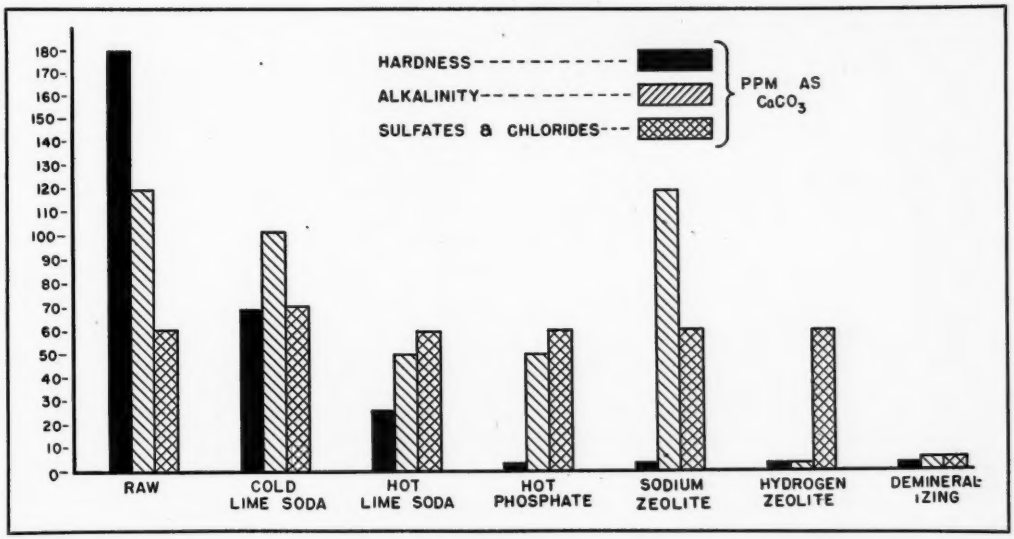
50 **Demineralizers**—This 26-page booklet describes briefly the chemical and mechanical principles of demineralization by ion exchange, and gives data on calculating costs for demineralizing various raw waters. A 2-page spread is devoted to each of the standard demineralizers offered by the company; a picture, an engineering drawing, specifications, performance data, and a parts description are given for each unit. Research and development facilities maintained by the company are also illustrated. American Cynamid Co., Ion Exchange Products Dept.

LIQUON

can give you.....

- **THE RIGHT PROCESS**
- **THE RIGHT EQUIPMENT**
- **THE RIGHT MATERIALS**

for conditioning your water supply



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And LIQUON recommendations are *authoritative,* as well . . . based on more than 30 years of specialized experience in this field, and the highly successful results obtained from LIQUON installations.

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 **Steam Generators**—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, municipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

52 **Double-Pass Boilers**—Bulletin R-M-1 (6th edition); illustrates and describes this line of riveted or welded double-pass steel firebox boiler. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 **Boilers, Burners, Accessories**—Bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.

54 **Standardized Boilers**—Bulletin 746: 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 **Steam Generators**—Presents reason for high efficiency; shows brief case histories of plants. Results of tests by independent authorities and "Facts You Should Know About Steam Generating Units." Ratings, dimensions and other data presented. Springfield Boiler Co.

56 **Steam Generator**—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawings and table of dimensions and sizes are given. Union Iron Works.

57 **Stirling Boilers**—Bulletin describing Type H Stirling boiler for low-head room use. Several specific installations of the unit are cited, dimensional data are given for various sizes and capacities of the units. The Babcock & Wilcox Co.

PRIME MOVERS

58 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. The Terry Steam Turbine Co.

59 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication, general; 10 pages. The Terry Steam Turbine Co.

60 **Turbines, Pumps, Products**—This 24-page catalog covers the company's complete line of products from steam turbines to flexible couplings. Every product is discussed from the design and operation angles and the discussion is heightened in interest by the inclusion of many excellent photographs. Other products discussed are helical gears, centrifugal pumps, multi-stage pumps, screw pumps, blowers, compressors and speed reducers. De Laval Steam Turbine Co.

61 **Turbine Cleaning Manual**—This 20-page bulletin covers the step-by-step solvent and manual cleaning of turbines from the inspection and preliminary cleaning to draining and final inspection. The cleaning and bearings and governor, installation of filter unit, circulation of cleaning solvent, and displacement of cleaning oil with new lubricating oil are steps which are covered briefly but clearly. Shell Oil Company, Inc.

62 **Steam Engines**—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

63 **Generating Sets**—Bulletin No. 108; General description, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

64 **Stationary Diesel Engines**—Dependability, adaptability of Diesel power described and applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

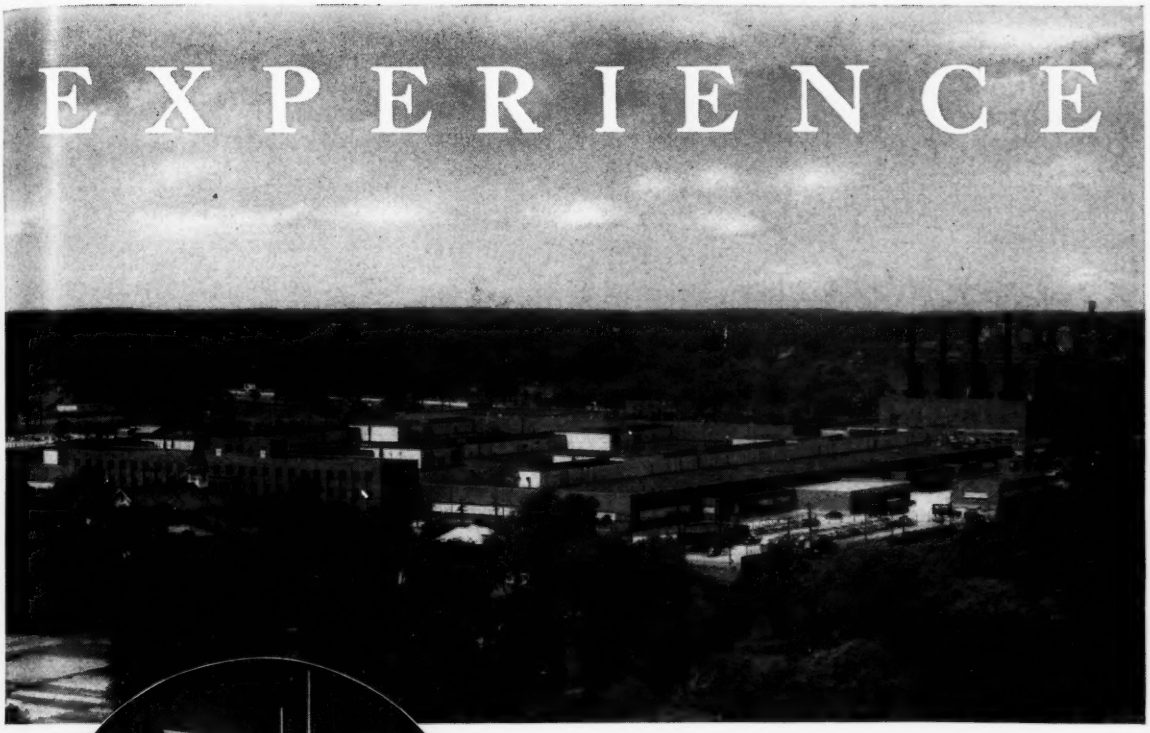
65 **Steam Engines**—Bulletin 306 describes vertical steam engines. Full page table of engineering information on Types E and ST engines is presented as is a section on construction details of such parts as piston and rod, cross head, crank shaft, etc. Well illustrated. Troy Engine & Machine Co.

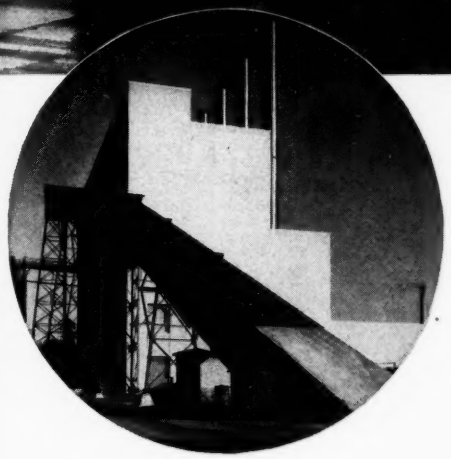
66 **Mechanical Drive Turbines**—Bulletin H-16 gives direction on selection of a unit and tabular material or general specifications and material specifications. Twenty one of the unit's features are pointed out and a large sectional drawing and a table of dimensions and a dimensioned line drawing also are shown. Elliott Co.

ELECTRICAL

67 **Oil Circuit Breaker**—Bulletin 71B-6421 describes Unitop oil circuit breakers; ratings from 15 to 46 kv. 500,000

EXPERIENCE





Stone & Webster Engineering Corporation designed and constructed this Plant at Fort Wayne, Indiana, for the Defense Plant Corporation. It was operated during World War II by General Electric Company.

DESIGNED and built during the War, this plant, now owned by General Electric Company, is an example of what Stone & Webster Engineering Corporation offers clients in the industrial fields.

STONE & WEBSTER ENGINEERING CORPORATION

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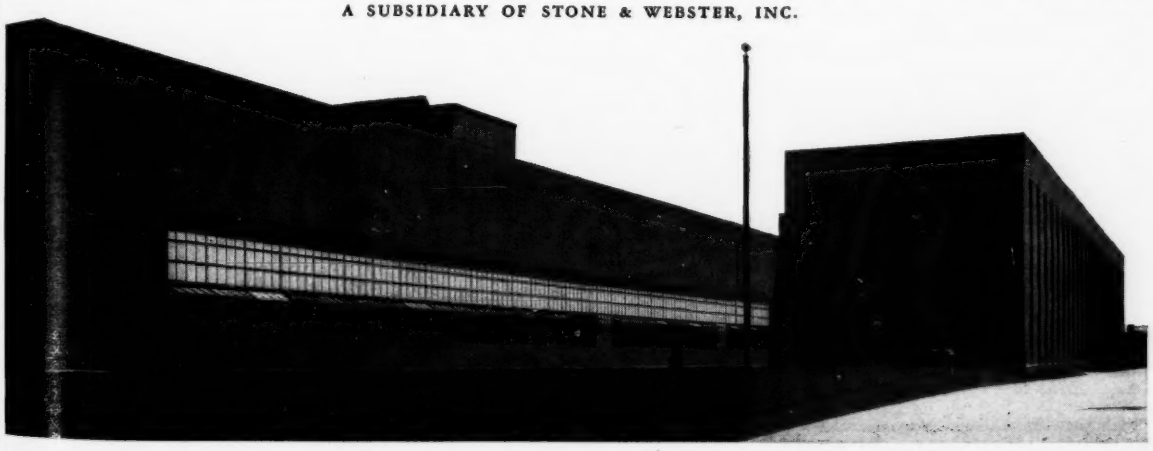

to 1,500,000 kva interrupting capacity. Well illustrated. Allis-Chalmers Mfg. Co.

68 **Generating, Substation Equipment**—Bulletin 25B6150 titled "More Power to U.S.A." 32 pages; sketches coverage of the company's equipment from hydro and steam turbines to switchgear and circuit breakers. Unusually well illustrated. Allis-Chalmers Mfg. Co.

69 **Fuse Booklet**—16-page pocket size booklet tells of outstanding construction features of fuses—such as the renewable link and spring tension locking of links in circuit. Full-page wash drawings are used to emphasize features. Two pages of price and specification data are included. Ware Brothers.

70 **Electrical Precipitation**—Cottrell Process is described and three gas cleaning problems—recovery of valuable material, cleaning for subsequent use, and the elimination of a nuisance are covered. Research Corp.

AUXILIARIES, ACCESSORIES

71 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

72 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.

73 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installation pictured and described. Drawings and text show proven results from experience of users, 2-page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

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High grade gas, by-product and steam coal from Wise County, Va., on the Interstate Railroad.

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High grade, high volatile steam and by-product coal from Wise County, Va., on the Interstate Railroad.

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A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

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Roda and Stonega from Wise County, Va., and Connellsville Coke from Pennsylvania.

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High grade gas, by-product, steam and domestic coal—Pittsburgh seam from Irwin Basin, Westmoreland County, Pennsylvania, on the Penna. Railroad.

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High fusion coking coal for by-product, industrial stoker and pulverizer use from Wyoming Co., W. Va., on the Vgn. Ry.

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BLUEFIELD, W. VA. BOSTON BUFFALO CHARLOTTE, N. C.
CINCINNATI NEW YORK NORFOLK PITTSBURGH

74 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L. P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

75 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbo-chargers, steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

76 **Heat Exchanger**—This new bulletin describes the company's Twin G-Fin Section; Bulletin 1614; section characterized as universal heat exchanger. Bulletin tabulates 21 features and corresponding advantages, describes design and construction. Installation views shown, field reports included; 16 pages. The Griscom-Russell Co.

77 **Evaporators**—Bulletin 364 describes, illustrates evaporators for various capacities and pressures; contains sections of special interest to plant engineers and executives; includes explanation of functions of evaporators, benefits obtained by their use; different types of evaporating systems and their association with plant balance. 26 pages. The Griscom-Russell Co.

78 **Soot Blowers**—Bulletin F45; soot blowers in general are described. Description and operation of units, materials and specifications and other pertinent information is presented; tables of steam consumption, boiler efficiency, fuel saving chart; boiler cross-sections with blower locations indicated thereon and installation drawings and data are included; 10 pages. Marion Machine, Foundry & Supply Co.

79 **Water Heater Capacity Ratings**—14 tables are included in this ratings booklet showing capacity ratings per hour for temperature rises of from 20 deg (50 to 70 deg) up to and including ratings for a 150 F temperature rise (50 to 200 F). Table No. 15 presents the rate of flow of steam through pipes with steam from an initial gage pressure of one pound up to 150 psi. Marion Machine, Foundry and Supply Co.

80 **Open Heaters**—Publication 4091, 24 pages, covers three lines of open heaters for direct contact heating of boiler feed water and industrial process water. Characteristics of design and operating information and installation photos are presented. Cochrane Corp.

81 **Coal Weighing Scales**—Description; outstanding features, specifications, line drawings, photos; 4 pages. Beaumont Birch Co.

82 **Steam Specialties**—Collection of folders steam trap, air trap, reducing valves, classes E, B and H pump governors, automatic boiler feedwater controller; parts and units list prices; descriptions; illustrations; tables of capacities. The C. E. Squires Co.

83 **Deaeration**—Data book; No. N-15 gives reasons for and principles of deaeration; cold water deaeration; tabular drawing and chart material presented; well illustrated; 20 pages. Elliott Co.

84 **How to Choose a Steam Trap**—Trap selection, trap rating, trap capacity factors, individual trapping, determining lift; traps for unit heaters, pipe coils, fan system heating surfaces, steam jacketed kettles, autoclaves, laundry equipment, paper makers, etc.; installation, operation, maintenance, instructions; specifications and capacities, corrosive service; 42 pages. The V. D. Anderson Co.

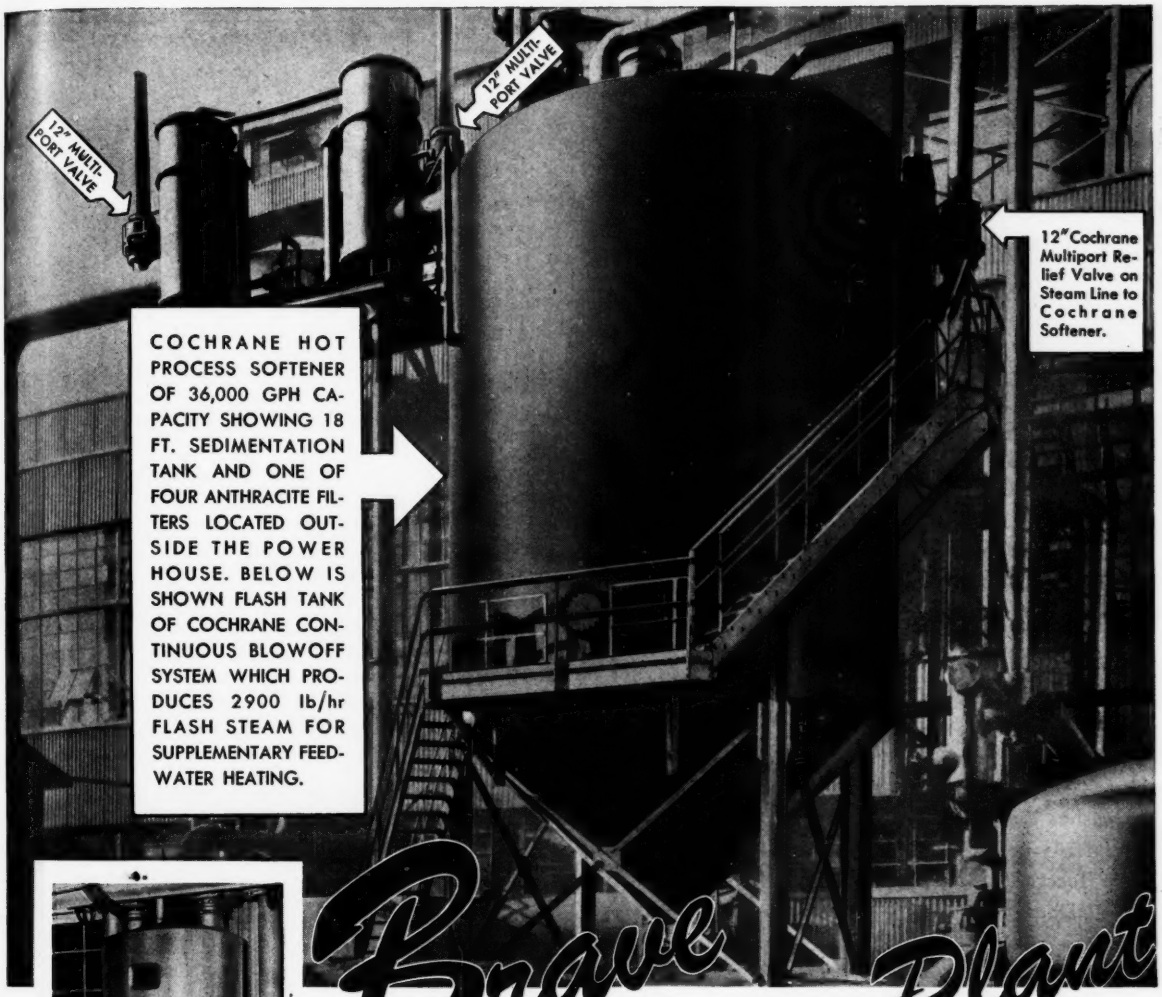
WATER TREATMENT

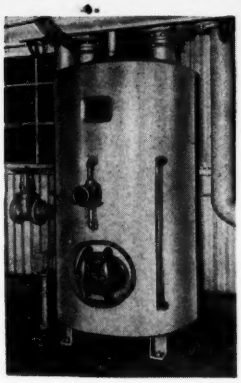
85 **Index for Calcium Carbonate**—Reprint of paper by John W. Ryznar; tables and charts; 16 pages. National Aluminate Corp.

86 **Boiler Feedwater Q & A**—Bulletin 30; 102 questions and answers on various problems of boiler feedwater; 16 pages. National Aluminate Corp.

87 **Water Treatment**—Scale and corrosion control in potable water supply; reprinted paper presented by Hanlon, Steffen, Rohlich and Kessler; 12 pages. National Aluminate Corp.

88 **Water Conditioning Service**—"The 6 Fundamentals of Betz Water Conditioning Service" illustrates and describes how this company extends a supervisory service for boiler water conditioning. Booklet shows complete operation of these 6 steps; 16 pages. W. H. & L. D. Betz.


12" MULTI-PORT VALVE
12" MULTI-PORT VALVE
12" Cochrane Multiport Relief Valve on Steam Line to Cochrane Softener.
COCHRANE HOT PROCESS SOFTENER OF 36,000 GPH CAPACITY SHOWING 18 FT. SEDIMENTATION TANK AND ONE OF FOUR ANTHRACITE FILTERS LOCATED OUTSIDE THE POWER HOUSE. BELOW IS SHOWN FLASH TANK OF COCHRANE CONTINUOUS BLOWOFF SYSTEM WHICH PRODUCES 2900 lb/hr FLASH STEAM FOR SUPPLEMENTARY FEEDWATER HEATING.



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with COCHRANE HOT PROCESS SOFTENER

COCHRANE CORPORATION 85 YEARS OF SERVICE 1863 - 1948

AT BRAVE, a village in southwestern Pennsylvania, the People's Natural Gas Company have a compressor station for which a new power plant was required. The Machinery Division of Dravo Corporation, Pittsburgh, was chosen to build the power plant. Obviously, all equipment selected was such as to insure the highest efficiencies combined with operating economy.

The result justifies this selection for not only is the compressor station handling more gas today than at any previous time in its history but coal consumption has been cut 100 tons per day!

The feedwater (100% makeup) for the boilers is obtained from a nearby creek and is treated in a 36,000 GPH Cochrane Hot Process Softener. A Cochrane Continuous Blowoff System maintains uniform boiler concentrations and provides low pressure steam for supplementary feedwater heating. The famous Cochrane Multiport Relief Valves are also used in this installation, one on the steam line to the softener and two on the barometric condensers.

Literature describing this equipment may be had by writing COCHRANE CORPORATION, 3123 North 17th Street, Philadelphia 32, Pa.

WHAT'S THE DIFFERENCE?

Outwardly, none. Friends easily can tell identical twins apart because they know the *hidden differences.*

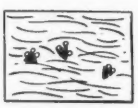
In water there are *hidden differences* too. K.A.T. was developed to meet this condition in your boiler. Since All-Colloidal K.A.T functions by physical action — not chemical reaction — it is effective against all impurities in any water regardless of composition.

ALL COLLOIDAL K.A.T.* WATER TREATMENT

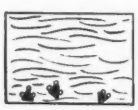
Employed as a complete or "finishing" treatment, user records show that K.A.T. improves boiler efficiency • Removes and prevents scale accumulation • Inhibits corrosion • Safeguards steam purity • Lowers fuel, labor maintenance costs • Permits almost continuous boiler operation.

K.A.T.

FIRST STAGE



SECOND STAGE



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Company.....

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City..... State.....

89 **Water Softener**—Bulletin 607; benefits and economies of soft water; typical applications; how it works; types; design and features; backwash and brine rinse regulators; how to modernize present softener; aerators, degasitors, chemical feed systems, chemicals; 20 pages. Elgin Softener Corp.

90 **Softener Handbook**—Manual, semi- and full-automatic zeolite water softeners are covered in Bulletin 315. Water softener plant is discussed in the first section and operating cycles and plant supervision is next considered. The third section is "Selecting Manual or Automatic Equipment"; this is accompanied by a table of comparison data. Graver Tank & Mfg. Co., Inc.

91 **Hot Process Water Treatment**—Form 326 is a case study bulletin; covers results of an installation of the company's hot process equipment at Kankakee Ordnance Plant. System was designed to provide 60,000 gph of properly conditioned water, free from hardness, scale forming minerals and corrisive gases. Graver Tank & Mfg. Co., Inc.

92 **Water Treatment**—Control of Fouling Organisms in Fresh and Salt Water, by John G. Dobson. Life history of these organisms; method of control. Wallace & Tiernan Products, Inc.

93 **Industrial Water Treatment**—Microbiological Control of and Through Industrial Waters; spot summaries of improvement of process efficiency and product quality of proper sterilization. Wallace and Tiernan Products, Inc.

94 **Cooling Water Treatment**—Bulletin 10 is an engineering information sheet on treatment of cooling water. A brief explanation of reaction in heat exchangers, condensers, etc., is presented. Bulletin describes necessary treatments. Liquid Conditioning Corp.

95 **Condenser Water Treatment**—Chlorination of Condenser Cooling Water, by R. B. Martin; important consideration in chemical treatment of cooling water circuits. Wallace & Tiernan Products, Inc.

96 **Clarifying and Softening Water**—Eight-page catalog "Reactivator for Clarifying and Softening Water by Upward Sludge Filtration." First part of the booklet tells how the reactivator works and how the sludge blanket is kept in control so as not to flow out with the clarified water. Line diagrams illustrate the principle of operation. Graver Tank & Mfg. Co., Inc.

97 **Feed Water Treatment**—This 4-page folder tells how the company's engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

98 **Chemical Feeding and Proportioning**—Bulletins 1100 and 1713A; use of adjustable chemical feeder for water treating, sewage, chemical processes, petroleum; plan and sectional diagrams; descriptions; photos; general specifications; 2-page table of capacity schedules; list of chemicals handled; accessories; drawings of boiler water conditioning systems; 5-page description of method of automatic intermittent feed of conditioning chemicals direct to the boilers; 20 pages. Proportioneers, Inc.

99 **Automatic Proportioning** — Bulletin 1200, 28 pages. Handy reference book containing wealth of information on automatic flow responsive equipment and methods in continuous process operation. Photos of equipment and installation are supplemented by many flow diagrams and detail drawings. Complicated subject made exceptionally clear and understandable by careful arrangement and two-color diagrams. Proportioneers, Inc.

100 **Water Conditioning Instruction Booklet**—Bulletin 28X6385 was written especially for guidance of power plant operators. It touches upon importance of feedwater control, care of test procedures. Handy reference tables given as aid to reporting results. Allis-Chalmers Mfg. Co.

101 **Complete Water Conditioning Service**—This 4-page bulletin describes this company's complete water conditioning service—analysis, design fabrication, installation and maintenance of water treating equipment. Typical installations are pictured and brief sketches of the men behind the service are given. Graver Tank & Mfg. Co., Inc.

COATINGS, TREATMENT

102 **Protective Coatings**—Four-page folder 844-246 describes Bitumastic Hi-

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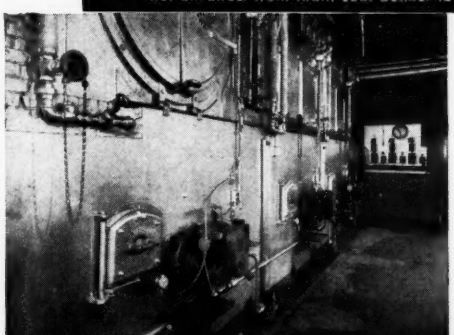

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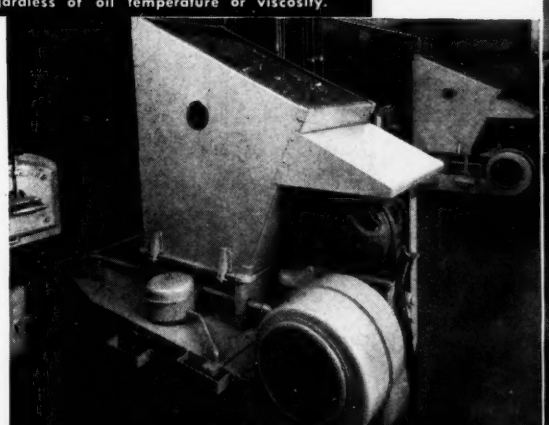

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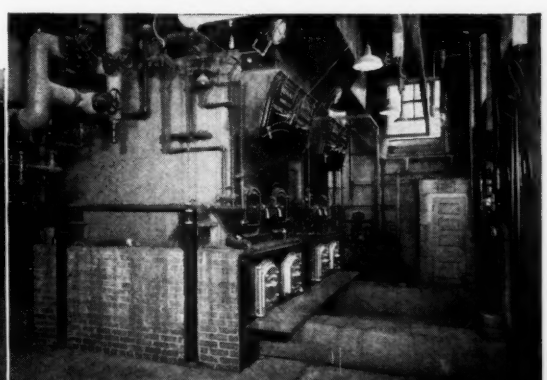
3 Built for continuous heavy duty, this large-capacity hopper model stoker combines worm feed and ram distribution.



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4 This underfiring stoker feeds direct from main coal bunker, eliminates manual coal handling.

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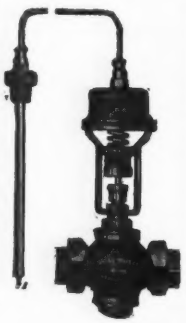

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Heat Gray, a specialized industrial protective coating which is said to resist corrosion and temperatures up to 1200 F. The folder is in two colors and contains several photographs of equipment on which Bitumastic has been applied. It also gives a list of uses for the material and a chart giving its characteristics. Walles Dove-Hermiston Corp.

103 Flue Cleaner—The company's soot and fire scale removing compound is described in this 6-page folder. Results obtained from the use of this compound are described in the first part of the folder and then a list of things which the company guarantees the material will accomplish are listed. Tables of dosage are presented and another table shows losses due to soot and fire scale. Dominion Chemical Co., Inc.

104 Boiler Water Treatment—Eight-page bulletin describes system of complete boiler water treatment. Group of photographs show how investigation is made at boiler plant to gather necessary data and how technical department studies water analysis and plant data. Discussion of "how complete boiler water treatment functions." E. F. Drew & Co., Inc.

105 Fuel Oil Treatment—Four-page bulletin presents engineering data on a fuel oil treatment for prevention and correction of unsatisfactory conditions in storing, pumping, heating, burning of industrial fuel oil. Two drawings show when treatment is used. Discussed is the problem of sludge. Application of treatment is explained. E. F. Drew & Co., Inc.

106 Fuel Oil Treatment—Several bulletins have recently been announced by this company describing completely the application and effect of its fuel oil treatment compound and Diesel engine solvents. Wilcolene Mfg. Co.

HEATING, COOLING

107 Cooling, Heating, Air Conditioning—Collection of bulletins; installation, design, construction data, capacity ranges, condensed physical data, numerous photos of installations, full page color diagrams of flow of air, compressed air, water, water spray, etc. Niagara Blower Co.

108 Insulating Cement—Ease of application, efficiency; ease of maintenance application recommendations; heat loss calculations, 4 pages. Baldwin Hill Co.

109 Water-Cooled Stoker—Catalog W; drawings of installations; features; furnace views; 8 pages. American Engineering Co.

110 Spreader Stoker—Installation views; features of various parts; cross-sectional view of furnace with installation; listed features; 8 pages. American Engineering Co.

INSULATION STOKERS

111 Coal Reference Bulletin—"600 Post-war Installations" of power plants in the United States are covered in Bulletin 10. Trend in new central stations and industrial plants is sketched and outstanding features of design of best stations described briefly. A table presents an industry classification of power plants by types of firing. Fairmont Coal Bureau.

112 Pneumatic Spreader Stoker—Three-fold booklet on the inner pages of which there are 30 spirally-bound vertical pages which fold back to tell the story of the stoker, installation, features, construction, principles, engineering, types and models, typical installations; well illustrated; 33 pages. Iron Fireman Mfg. Co.

113 Poweram Stoker—Bulletin 7121; essentials of successful stoker; fuel control, fuel convoying, fan capacity, controls, installation; illustrations; 18 pages. Iron Fireman Mfg. Co.

114 Coal Reference Bulletin—Bulletin 8, Underfeed Stoker Firing, Bulletin covers factors involved in selection of multiple retort stokers, principles, design data and drawings of typical installations; 6 pages. Fairmont Coal Bureau.

115 Stoker Firing Operation—Single Retort Underfeed Stoker Firing is the subject of Bulletin No. 9 issued by this Bureau. It is a complete analysis of the advantages of the single retort stoker in the smaller plants. Types of this stoker are described and principles of operation are outlined. Fairmont Coal Bureau.

OIL, GAS BURNERS

116 Wide Range Oil Burning System—Bulletin 107; how the system operates; control, drawings; 4 pages. Peabody Engineering Corp.

117 Oil Burners—Bulletin 108. Two types of oil burners, A and H; air registers, oil atomizers, drawings; 4 pages. Peabody Engineering Corp.

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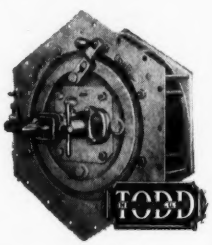

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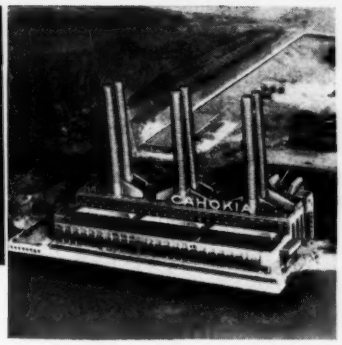
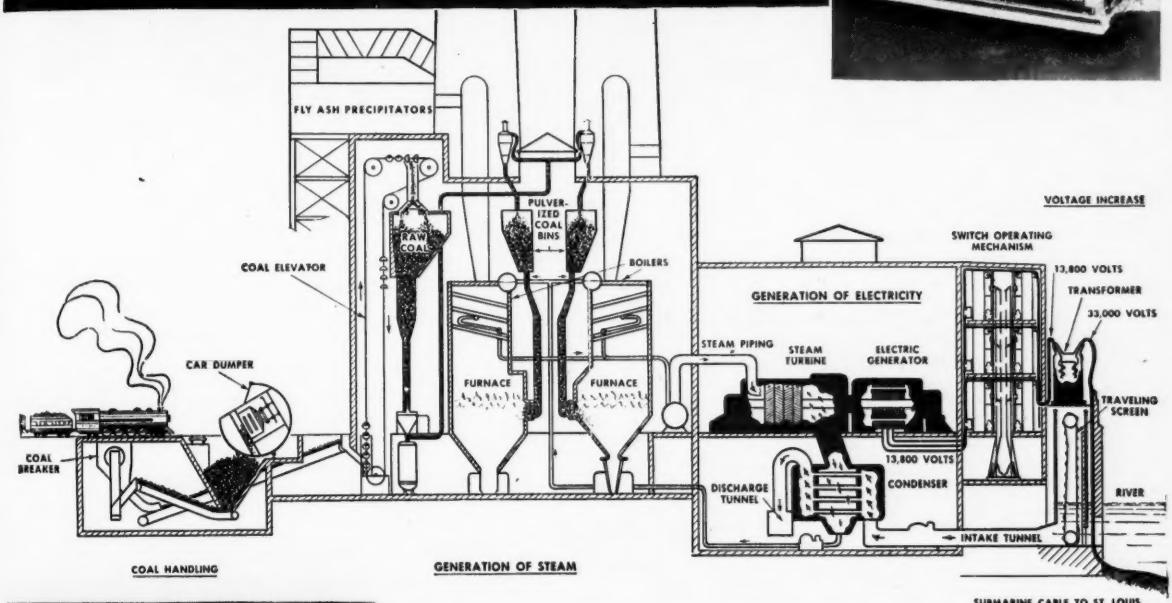
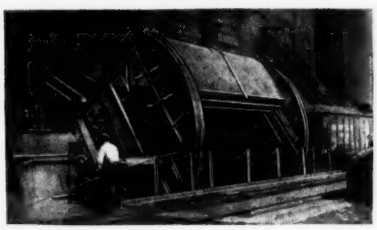
Unloads, Stores, Reclaims Coal at Cahokia Station







Above: Link-Belt Rotary R. R. Car Dumper in action. It was installed in 1923, when first section of the Cahokia Station was built.
Below: Shows coal being discharged from stocking-out conveyor and how tractor-mounted scrapers or bulldozers are used for moving initial storage pile, spreading the coal, and compacting it throughout storage yard.

Pulverized coal plant of Union Electric . . . first section built in 1923

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118 **Oil Burner**—Wide-range Y-jet steam atomizing oil burner is described. Construction, application and advantages of unit are shown and bulletin tells how burner has established excellent standards of performance. The Babcock & Wilcox Co.

OIL, LUBRICATION

119 **Lubrication Recommendations**—Special oils for Diesels and heavy-duty gasoline engines; facts about oil; tables of recommended oils for various models; 18 pages. Standard Oil Company of California.

120 **Cutting Fluids**—Facts about cutting fluids, machine tool operations; fundamentals of cutting; how to apply; metallic cutting tools; tabular material; shop practices; 50 pages. Standard Oil Company of California.

121 **Diesel Operation**—Relation of fuels and lubricants to the operating efficiency of the diesel engine; diesel fundamentals; maintenance; lubrication and fuels; supercharging; selection and classification of fuels; fuel injection maintenance; improving cleanliness; tabular material, charts, formulas; 114 pages. The Texas Co.

122 **Engineers Report on Oil**—Engine tests, laboratory tests, effects on engines, bearing corrosion, actual service data, filter clogging, service experience; well illustrated with photos and charts; 42 pages. Standard Oil Company of California.

123 **Lubricants Service Handbook**—28 pages in this booklet on lubricants and their application. The development of the lubricant, its features and advantages and the manner in which it meets various operating conditions take up the fore part of the booklet. "Recommendations" section where the manufacturer tells just what grease or oil should be used according to speeds, temperatures, pressures and general service conditions is given. Fiske Brothers Refining Co.

124 **Oil Products for Industry**—Cutting oil, processing oils, general lubricants, refrigeration oils, Diesel oils, solvents, greases and waxes are among the petroleum products for industry which are described in this 4-page folder. The various grades of each oil are analyzed and the reasons why they are fitted to each particular job are given. Sun Oil Co.

POWER TRANSMISSION

125 **Speed Reduction, Increase Gear**—Bulletin S-130; description; gear cases; gear and pinion; bearings; lubrication; drawings and photos; 8 pages. The Terry Steam Turbine Co.

126 **Flexible Couplings**—Bulletin 57; two pages of drawings and tables of ratings for company's flexible couplings. Installations are shown and features of the various types are discussed; 20 pages. John Waldron Corp.

127 **Fluid Drives**—Bulletin 8019 tells about automatic fluid speed drives for 3600 rpm boiler feed pumps. Cutaway illustration and curve shows operational improvement and construction and operating features are pointed out. American Blower Corp.

VALVES

128 **Regulating Valve**—Bulletin 1-A; valve data book, description, dimensions and lists of parts; typical installations, rated capacities; prices; 52 pages. Atlas Valve Co.

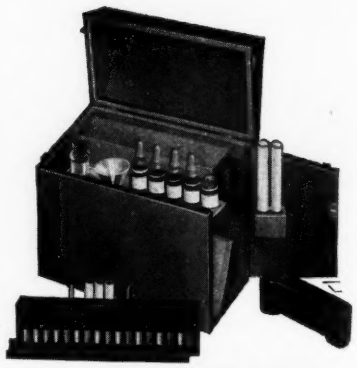
129 **Pressure Reducing Valve**—Bulletin 1-C; sectional drawings, list prices, dimensions and weights; operation and adjustments; capacities for steam and air; 12 pages. Atlas Valve Co.

130 **General Service Valve**—Bulletin E-150; valves for blow-off; fire protection, soot blower lines, acids, process, etc.; description; exploded views; features; dimensions, weights and list price tables; parts and parts lists; 14 pages. Everlasting Valve Co.

131 **Valve**—Bulletin E-100; for boiler room service; photos; descriptions, parts; features; pressure rating indexes; size, shipping weight and price tables; ordering information; 30 pages. Everlasting Valve Co.

132 **Diaphragm Motor Valve**—24 pages. Covers Why and How of unit's design. Materials specifications given as are two pages of engineering information and charts. Kieley & Mueller, Inc.

133 **Butterfly Valves**—Bulletin 77 describes butterfly valves especially de-



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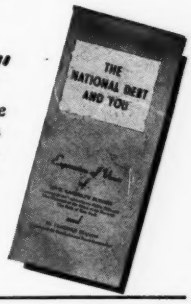

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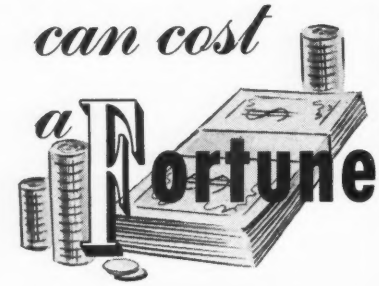

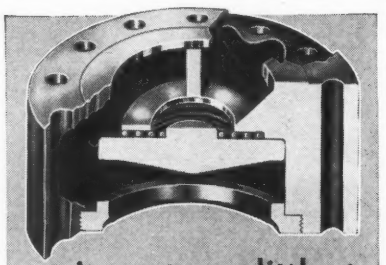

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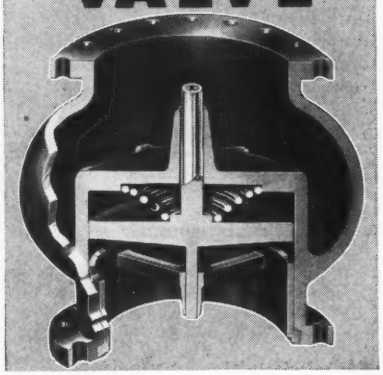

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signed for diaphragm motor valve operation. Characteristics and construction features described; a chart shows flow characteristics taken from actual tests. Sectional and detailed drawings of valves are used to list various parts. Fisher Governor Co.

134 **Control Valves**—Catalog 546 covers line of control valves for air, gas, oil, steam or water up to 500 psi. Applications are described and line drawings, detailed engineering information and material classifications are presented. W. H. Nicholson & Co.

135 **Air Release Valve**—Operation, construction and essential requirements of air release valves described in Bulletin 140. Discusses dangers of air in pipe lines and solution to problem. Simplex Valve & Meter Co.

136 **Self-Cleaning Strainers**—Bulletin 465 presents tables of screen specifications and total free hole area to facilitate correct screen selection. Tables of dimensions of cast iron, cast bronze, cast steel and stainless steel strainers. Charts, illustrations and photos complete bulletin. Leslie Co.

MAINTENANCE

137 **Maintenance Jobs**—This guide tells how better to perform commonly occurring power plant maintenance and cleaning operations. Illustrated manual gives specific material and method recommendations for handling cleaning, degreasing, descaling, derusting, paint stripping, etc. Booklet is completely indexed and reference is made by colored type strips on edge of the pages; 22 pages. Oakite Products, Inc.

138 **Condenser Tube Inserts**—Description of Flowrites; illustrated, accompanied by report of tests on Flowrites made by M.I.T. Tables and charts of test results are presented; description of how to install inserts given; 8 pages. Condenser Service & Engineering Co., Inc.

139 **Building Maintenance Guide**—"Over the Rough Spots," provides answers to more than 100 problems inherent in maintenance and construction of all types of buildings. Its 48 pages are packed with information about floors, walls, foundations, roofs, etc. Special information of interest to railroads, mines, utilities and water works. Stonhard Co.

CONTROLS, METERS

140 **Damper Regulators**—Bulletin 4-A; for low pressure heating, medium pressure power and high pressure power boilers; what they do; how to specify; typical installations (drawings); adjustments; list prices; technical descriptions and parts lists; 20 pages. Atlas Valve Co.

141 **Recording Flow Meter**—Bulletin 349; what it does, features, chart of rated capacity; construction and operation; installation drawings, tables of capacity, photos; 8 pages. Builders-Providence, Inc.

142 **Propeller-Type Meter**—Bulletin 350A; for main-line metering; applications, description, installation, materials of construction; features; table of capacity, shipping weights; specifications, drawings; 4 pages. Builders-Providence, Inc.

143 **Centralized Combustion Control**—Bulletin 43-605; application to various types fuels and burning equipment; controller, measuring elements, pilot device, power units, etc.; 24 pages. The Hays Corp.

144 **Combustion Meters**—Bulletin 44-550; reasons why it is accurate, dependable, simple, rugged, easy to install, easy to maintain, speedy, easy to understand; well illustrated by explanatory diagrams; 16 pages. The Hays Corp.

145 **Remote Feed Water Control**—Bulletin 471 describes Type P regulator for remote control of boiler feed water. Construction features of unit are described and complete hook-ups of the regulator with different types of valves are shown. Complete descriptions of hook-ups are given. Northern Equipment Co.

146 **Liquid Level Indicators**—Bulletin WG-1822, 16 pages, describes liquid level indicators for boilers, heaters and other vessels in industrial and central stations. Construction and operating details are covered. Installation instructions and specification information given. Yarnall-Waring Co.

147 **Electronic Instruments**—Bulletin 231 describes recently-developed line of electronic instruments for temperature, flow and other factors. Measuring circuits are described and diagrams presented;

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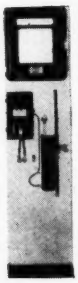

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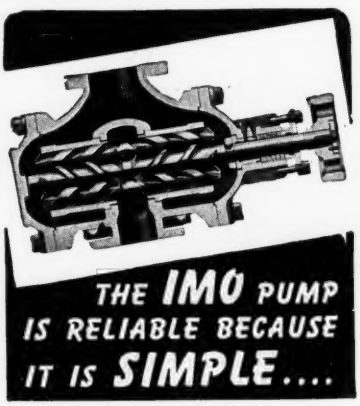

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these diagrams include resistance bridge, potentiometer circuits, impedance bridge and calculating circuits. Bailey Meter Co.

148 **Feed Water Regulation**—Bulletin 429B, 12 pages, covers the company's automatic flow regulator for controlling boiler feed water. Photos of installations, charts and studies of boiler water level control under various conditions of pressure and information on operation and construction of the unit are given. Specifications are listed. Northern Equipment Co.

149 **Engineering Monographs**—Series of eight on automatic combustion control: 1. How Close Can Steam Pressure Be controlled? 2. Why Operate Automatic Combustion Control from Changes in Steam Pressure? 3. Adapting to the Characteristics of Underfed Stokers. 4. Adapting to Spreader Type Stokers. 5. Adapting to Chain or Traveling Grate Stokers. 6. Adapting to the Characteristics of Pulverizers. 7. Adapting to the Characteristics of Oil Burners. 8. Adapting to the Characteristics of Gas Burners; total 37 pages. The Hays Corp.

150 **Draft**—Bulletin 46-472; what draft is; where it is found; how it is measured; what the draft gage tells, where to measure draft and pressure in steam plant; where to connect draft gages; how to install; drawings; 20 pages. The Hays Corp.

151 **Flue Gas Analyzer**—Bulletin 45-668; principle of operation; construction features; technique; models and prices; Burrettes—classification and uses (table); what flue gas analysis tells us; 16 pages. The Hays Corp.

152 **Indicating, Control Systems**—What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

153 **Water Gages**—Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

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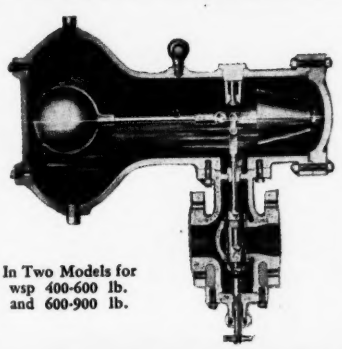

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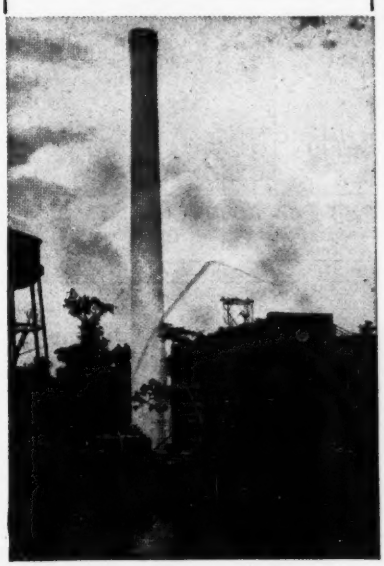

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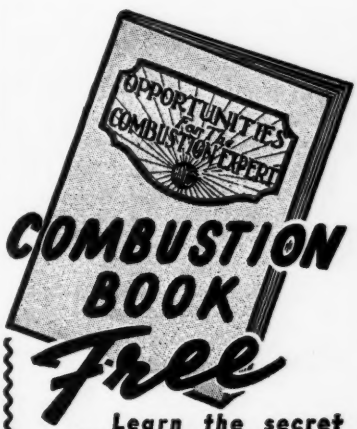

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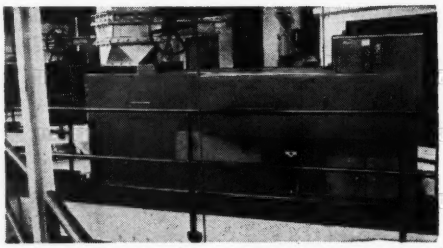

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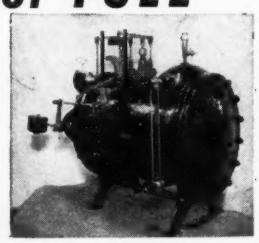

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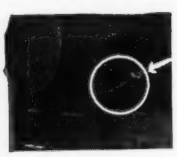

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154 Stainless Steel Bellows—Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors for flow control, vapor and steam traps, thermostatic instruments, etc. Completely illustrated; 12 pages. Chicago Metal Hose Corp.

155 Pitot Equipment—Three section Bulletin 50; gives complete details of the use of Pitot tubes and rods, instructions in the use of the company's portable Pitot recorder, together with theory, formulae, notations and curves. Completely indexed; 20 pages. Simplex Valve & Meter Co.

156 Temperature Regulators—Bulletin 7-A; six types; descriptions; list prices, tabular material, photos; list of parts; typical installation drawings; tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

157 Liquid Level Controllers—Bulletin A-100 is a 4-page catalog describing this company's Types G and D liquid level regulators. Excellent cross-sectional views of the units are presented and their operational and constructional features are described. Dimensions, capacities and shipping weights are presented. Stets Company.

158 Boiler Feed Control—Bulletin 463, 16 pages, describes boiler feed control systems at Westover, Greenidge and Jennison Stations of N. Y. State Electric and Gas. Corp. Completely illustrated with photos and line drawings. Tables of significant data included, Northern Equipment Co.

159 Water Level Control—"Controlling Water Level on Combustion Engineering Type VU Boiler" is title of Bulletin 455. These four pages present photos and chart reproductions and tell the details of the company's control equipment on this particular type of boiler. Northern Equipment Co.

160 Water Level Control—Bulletin 459, 8 pages, description of water level control installation at Wyman-Gordon Co. Good illustrations show details of installation. Table of significant data given. Northern Equipment Co.

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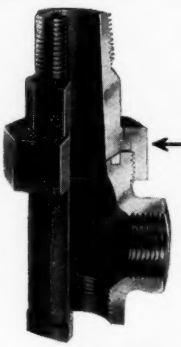

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161 **Boiler Water Level Control**—Bulletin 467 and 465, 8 pages each, describe, respectively, control installations at Buzzard Point plant and West Reading Station. Both give exceptionally detailed reports of the installation complete with tables, photos and drawings. Northern Equipment Co.

PACKING GASKETS

162 **Metal Packings**—Bulletin filled with information on line of metal packings for industrial use. Understandable line drawings accompany descriptions. Packing rings, wiper rings and piston rings also are described and illustrated. France Packing Co.

FITTINGS

163 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

164 **Welding Fittings**—Volumetric capacities, 2 pages of formulas for computation of capacities; 6 pages of tables; 12 pages in book. Tube Turns, Inc.

165 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship; 24 pages. Jefferson Union Co.

166 **Welding Fittings**—Bulletin 47-1 covers stainless steel welding fittings . . . 90 deg elbows, 45 deg elbows, 180 deg returns, lap joint stub ends, tees, caps, reducers. Specifications for each type are presented and tables give complete dimensional data. Information on welding of stainless steel is given. Midwest Piping & Supply Co., Inc.

PUMPS

167 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawings, tables; 4 pages. Warren Steam Pump Co., Inc.

168 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

169 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers; viscosity classifications; 18 pages. Sier-Bath Gear & Pump Co., Inc.

170 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained. Typical use of the units are pointed out and installation and operation explained; 20 pages. Marlow Pumps.

171 **Pedestal Type Pumps**—Listed in tabular form are heads and capacities of these units, also given is a Pump, Motor. Drive table. Operating advantages are listed and illustrated and features of construction are outlined. Allis-Chalmers Mfg. Co.

172 **Materials Handling Pump**—Catalog 547 describes all late developments in the "Hydroseal" pump. Line drawings and colored illustrations picture improvements in construction and tables show performance based on clear water. "Calculating the Pump Required," is a highly useful section of the bulletin. The Allen-Sherman-Hoff Co.

MISCELLANEOUS

173 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Prices are given. Syntron Co.

174 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Lumnite Division, Universal Atlas Cement Co.

175 **Gas Purger for Refrigeration System**—Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages, and complete illustrated material; 8 pages. Armstrong Machine Works.

176 **Vapor Cleaning Unit**—Latest equipment for steam detergent cleaning described in Form 6327R. Features of simple operation, control and delivery outlined by means of pictures. Engineering specifications and operating data given. Oakite Products, Inc.

177 **All-Purpose Electric Tool**—Electric impact tool which, using standard attachments, will apply and remove nuts, drill, ream, tap, drive and remove screws and studs, extract broken cap screws and studs, run wire brushes, do hole saw work, drill brick and masonry and drive wood augers. Photos show machine in operation on many jobs; description of tool given. Ingersoll-Rand.

178 **High Side Floats**—Bulletin 178 describes inverted bucket high side floats for discharging liquid refrigerant to the low side of refrigerating systems. Five stages of operation are shown in drawings. Armstrong Machine Works.

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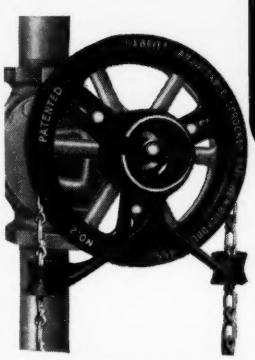

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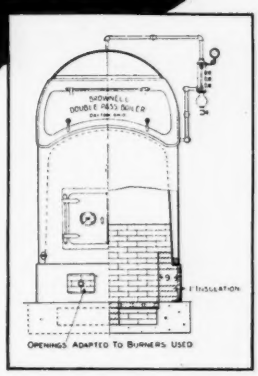

Drawing of Brownell Double-Pass Firebox Boiler arranged for oil or gas firing.

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POWER PLANT *Construction News*

Ark., Pine Bluff—Arkansas Power & Light Co., Pine Bluff, is arranging a five-year expansion and improvement program in power plants and system, estimated to cost about $88,000,000. Work will include two new steam-electric generating stations on sites to be selected, each to cost approximately $6,400,000, including power substations, transmission lines and other operating facilities.

Colo., Denver—Public Service Co. of Colorado, 900 15th St., has plans under way for new steam-electric generating station on local site at West Vassar Ave. and Navajo St., to be equipped for initial rating of about 80,000 kw. Cost reported close to $14,000,000 with power substations, transmission lines and other operating facilities. Ebasco Services, Inc., 2 Rector St., New York, N. Y., is consulting engineer.

Colo., Durango—Western Colorado Power Co., Durango, plans addition to local steam-electric generating station for expansion in steam department. Cost estimated about $150,000, with equipment. Work is expected to begin in spring.

Ill., Stickney — Commonwealth Edison Co., 72 West Adams St., has plans under way for new generating plant at 4300 South Ridgeland Ave., Stickney, near Chicago, where site has been selected. It will be equipped for initial capacity of 150,000 kw, and is estimated to cost about $36,000,000, including power substations, transmission lines and other facilities. Sargent & Lundy, 140 South Dearborn St., Chicago, are consulting engineers.

Ind., South Whitley—Town Council plans expansion and improvements in municipal power station, including installation of new Diesel engine-generating unit and accessory equipment. Bond issue of $105,000 is being arranged.

Iowa, Keosauqua—Town Council has engaged Harold Hoskins & Associates, Trust Bldg., Lincoln, Neb., consulting engineers, to prepare plans for proposed new oil engine-operated municipal power plant, recently referred to in these columns. Bids are expected to be asked soon. A bond issue of $220,000 has been authorized for project.

Kan., Riverton—Empire District Electric Co., 602 Joplin St., Joplin, Mo., plans new steam-electric generating station in vicinity of present power plant at Riverton, to be equipped for initial capacity of 30,000 kw. Cost estimated about $4,500,000. This is part of an expansion and improvement program to be carried out during next 36 mos., entire project to represent investment of about $9,500,000.

Md., Braddock Heights—Braddock Light & Power Co., 929 E St., N. W., Washington, D. C., is considering construction of new steam-electric generating station at Braddock Heights, with initial rating of 80,000 kw, divided into two 40,000-kw turbine-generator units. Estimates of cost are being made.

Mont., Butte—Montana Power Co., Butte, plans addition to hydroelectric power station on Flathead River, with installation of new hydraulic-electric generating unit. No estimate of cost announced. Proposed to begin work soon. Permission has been granted by Federal Power Commission, Washington, D. C.

N. J., Harrison—Public Service Electric & Gas Co., Public Service Terminal, Newark, N. J., has preliminary plans under way for addition to artificial gas plant at Harrison, with installation of new generating equipment, gas holder and other facilities. Adjoining tract of about 80 acres of land has been acquired. Proposed to begin work early in 1949. Project will represent large investment.

N. C., Lumberton—Carolina Power & Light Co., Raleigh, has preliminary plans and surveys under way for new steam-electric generating station on Lumberton River, about 3 mi. from town limits, where site is being secured. Estimates of cost and details will be determined soon.

Ohio, Akron — Ohio Edison Co., 47 North Main St., Akron, has plans under way for expansion in local Gorge generating plant, including new multi-story addition and installation of equipment for increased output. It is understood that work will begin this spring. Cost reported close to $2,000,000.

Okla., Perry—Municipal Light & Water Dept. has plans maturing for expansion in oil engine-operated power plant, with installation of new Diesel engine-generator

and accessory equipment. Cost about $150,000. V. V. Long Engineering Co., Colcord Bldg., Oklahoma City, Okla., is consulting engineer.

Okla., Shawnee—City Council, Erbin Jones, city manager, plans installation of new Diesel engine-generating unit for service in municipal waterworks station. Fund of $80,000 for this and other work was authorized a number of months ago.

Ore., Merrill—Bureau of Reclamation, Denver Federal Center, Denver, Colo., has plans for new pumping plant near Merrill, to be known as Adams pumping station, to be equipped for rating of 60 cu ft per sec. Proposed to ask bids soon, Klamath project, California-Oregon.

Pa., Clarks Summit—State Dept. of Property and Supplies, Harrisburg, plans extensions and improvements in boiler house at State Hospital at Clarks Summit, with installation of new boilers for central-heating service and auxiliary equipment. Project will be carried out in conjunction with other improvements at institution, entire program to cost about $645,000.

Pa., Pittsburgh—West Penn Power Co., 14 Wood St., has arranged fund of about $40,000,000 for expansion and improvements in power plants and system during present year. Work will include installation of first 80,000-kw turbine-generator unit, high pressure boilers and other equipment in new Mitchell generating station, now in course of erection and previously noted in these columns. Another turbine-generator of like rating will be installed at later date.

Pa., Spring City—State Dept. of Property and Supplies, Harrisburg, Pa., has plans under way for expansion and improvements in boiler plant at Pennhurst State School, Spring City, used for central-heating service, with installation of new boilers and other equipment. This is part of an expansion and betterment program at institution, entire project to cost approximately $750,000.

S. D., Martin—La Creek Electric Association, Inc., Martin, plans expansion in generating plant, with installation of additional equipment for increased capacity. Financing in amout of $585,000 has been arranged through Federal aid for this and line extensions.

Tenn., New Johnsonville—Tennessee Valley Authority, Chattanooga, Tenn., plans new steam-electric generating station at New Johnsonville, where site has been selected. Project will be carried out over a period of several years, with ultimate station capacity of 375,000-kw, divided into three 125,000-kw turbine-generator units. Entire project is estimated to cost about $54,000,000, with initial expenditure in 1948 to approximate $4,000,000. Appropriation is now being considered by Congress. Proposed to have two generating units in service early in 1952.

Texas, Austin—Water, Light & Power Dept., Municipal Bldg., plans new municipal steam-electric generating station in vicinity of present city-owned plant. Details of equipment installation will be determined at early date. Cost reported about $2,500,000. A number of new power substations are planned, with extensions in transmission lines, to cost approximately $600,000, in addition to amount noted.

Texas, Port Aransas—Mustang Island Industries, Inc., plans expansion and improvements in local oil-operated generating station, with installation of new Diesel engine-generator unit and auxiliary equipment. Cost estimated about $100,000. Proposed to begin work soon.

Texas—Witco Hydrocarbon Corp., recently organized subsidiary of Witco Chemical Co., 295 Madison Ave., New York, N. Y., plans large compressor station and boiler house at new natural gas processing plant in Barnhart oil field area, Regan County, Tex., where tract of land has been secured. Plant will be used for production of natural gasoline and carbon black, and will represent an investment of about $3,500,000. C. E. McKinney is vice-president in charge of operations.

Utah, Salt Lake City—Utah Power & Light Co., Kearns Bldg., Salt Lake City, plans extensions and improvements in plants and system during 1948 to cost about $5,800,000, including increased generating capacity, new power substation at Malad City, transmission lines and other work. Ebasco Services, Inc., 2 Rector St., New York, N. Y., is consulting engineer.

Wis., Green Bay—Wisconsin Public Service Corp., Bellin Bldg., Green Bay, will begin work in spring on superstructure for addition to Bayside steam-electric generating station, previously referred to in these columns. New turbine-generator unit and auxiliary equipment will be installed for increased capacity. Entire project will cost about $5,250,000. Public Utility & Engineering Service Co., 231 South La Salle St., Chicago, Ill., is consulting engineer.

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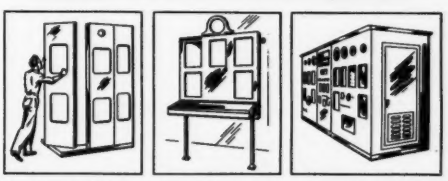

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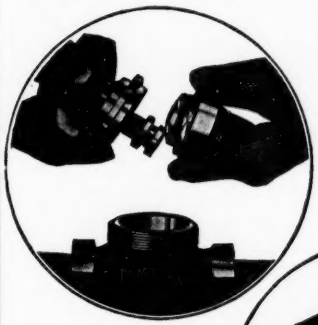

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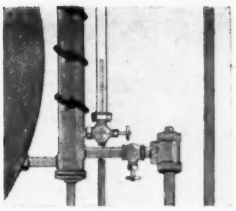

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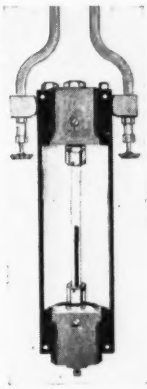

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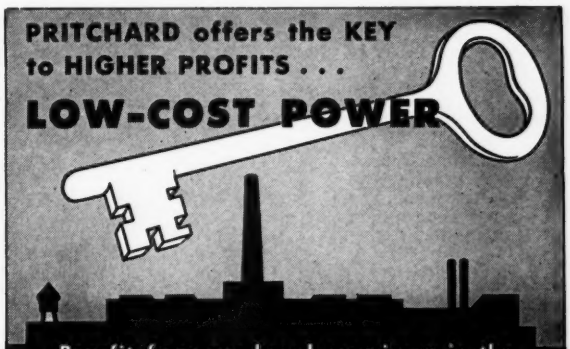

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Chapman Valve Mfg. Co., The...
..... Inside Back Cover
Chicago Metal Hose Corp. 119
Cities Service Oil Co. 42
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Clipper Mfg. Co. ..... *
Cochrane Corporation 151
Combustion Engrg. Co., The....16-17
Crane Co. 45

Dampney Co. of America, The.... *
Dart Mfg. Co., E. M. 136
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DeLaval Steam Turbine Co.
.....35, 137, 158
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Edge Moor Iron Works, Inc. 115
Edward Valves, Inc. 4
Elliott Co. 2-3
Engineer Co., The..... *
Enterprise Engine & Foundry Co.141
Erie City Iron Works.....145
Everlasting Valve Co. ..... *

Fairmont Coal Bureau.....143
Falstrom Company 163
Farris Engrg. Co. 144
Fisher Governor Company..... *
Flexo Supply Co. ..... *
Fluor Corporation, Ltd., The.....113
Foster Engrg. Company..... 51
Foster Wheeler Corp. 22-23
France Packing Co. 156
Fuller Company 140

Gamlen Chemical Co.....164
Garlock Packing Co., The..... 18
General Coal Co. 150
General Electric Co. ..... *
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Green Fire Brick Company, A. P.. 43
Grinnell Co., Inc. 105
Griscom-Russell Co., The..... *

Haering & Co., Inc., D. W.....148
Hagan Corporation 24-25
Hall Laboratories 14-15
Hays Corporation, The..... *
Hays Institute of Combustion....159
Henszey Company 142
Huyette Co., The Paul B..... *

Illinois Water Treatment Co..... *
Infilco, Incorporated ..... *
Ingersoll-Rand Co. ..... *
International Nickel Co., Inc., The 34
Iron Fireman Mfg. Co.....153

Jefferson Union Co. 160
Jeffrey Mfg. Co., The..... *
Johns-Manville 128, 129

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Kieley & Mueller, Inc. 31
Klipfel Mfg. Co. ..... *

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Link-Belt Co. 155
Liquid Conditioning Corp.....147
Liquidometer Corp., The..... *

Marley Company, Inc., The..... *
Marlow Pumps ..... *
Maxim Silencer Company, The...162
McNeill Engrg. Co. 165
Metalock Casting Repair Service.130
Midwest Piping & Supply Co., Inc. 30

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National Aluminate Corp. 36
National Boiler Protector Co.....160
Neff & Fry Co., The..... *
Niagara Blower Co. ..... *
Nicholson & Co., W. H.....159
Northern Equipment Co..... 53

Oakite Products Co.....152

Peabody Engrg. Corp. ..... *
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Permutit Co., The.....Back Cover
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Roto Div. of Elliott Co.....132

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Sier-Bath Gear & Pump Co., Inc..146
Simplex Valve & Meter Co.....122
Sinclair Refining Co.....26-27
Standard Oil Co. of California...109
Standard Oil Co. (Indiana)....12-13
Steammaster Automatic Boiler
Co. ..... *
Sterling Engrg. & Mfg. Corp.....160
Stets Company 159
Stone & Webster Engrg. Corp....149
Syntron Company ..... *

Taylor & Co., W. A.....156
Templeton Brothers ..... *
Terry Steam Turbine Co., The... 28
Texas Co., The..... 9
Thermix Corp., The..... *
Tide Water Associated Oil Co..... *
Todd Shipyards Corporation
(Combustion Equipment Div.)..154
Treasury Department 157
Trimount Instrument Co.....165
Troy Engine & Machine Co.....138
Tube Turns, Inc.....19-20

United States Steel Corp.....126
Universal Atlas Cement Co.
(Luminite Division) 126

Vogt Machine Co., Inc., Henry...125

Wailes Dove-Hermiston ..... *
Wallace & Tierman Products, Inc.121
Warren Steam Pump Co., Inc.....133
Western Precipitation Corp.....123
Wheeler Mfg. Co., C. H..... *
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Wickes Boiler Co., The..... 33
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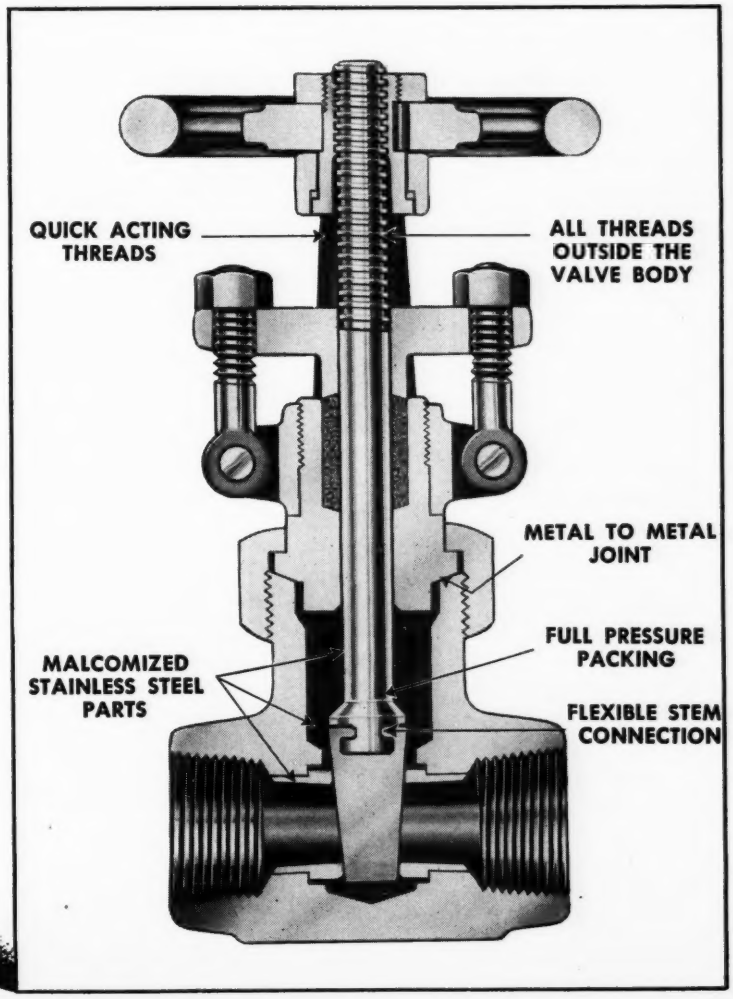

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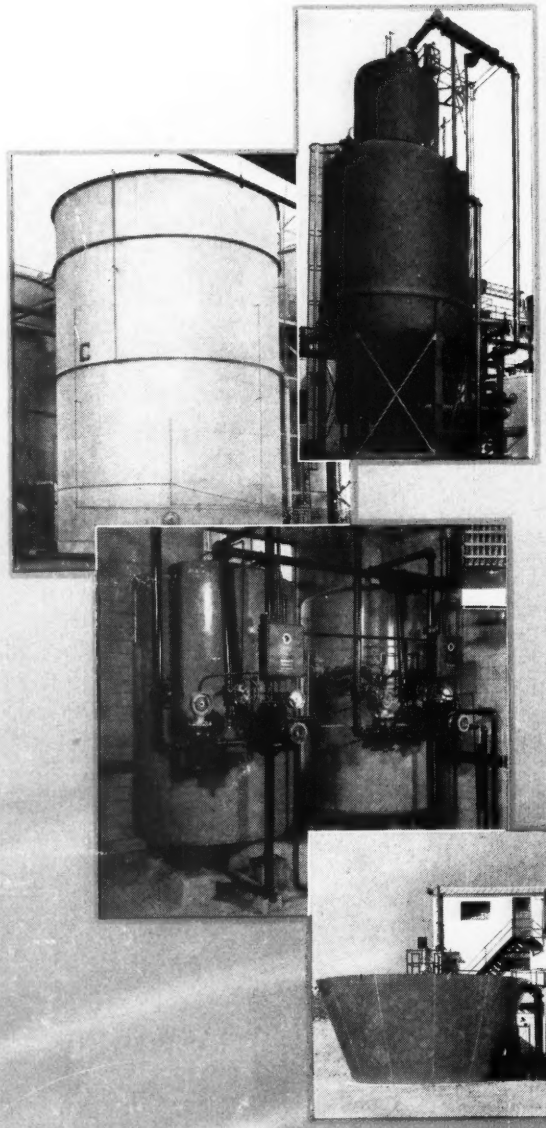

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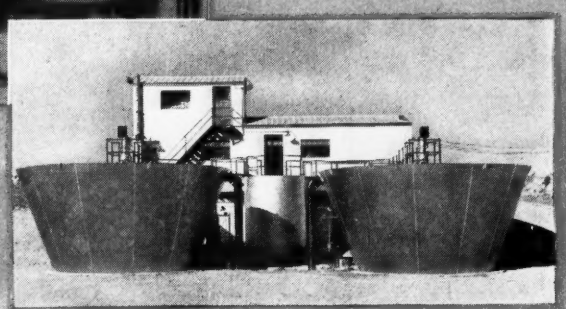

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